STATUS OF THE REHABILITATION OF EISENHOWER AND SNELL LOCKS, ST. LAWRENCE SEAWAY

(100-43)

HEARING

BEFORE THE

SUBCOMMITTEE ON
INVESTIGATIONS AND OVERSIGHT

OF THE

COMMITTEE ON
PUBLIC WORKS AND TRANSPORTATION
HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

FIRST SESSION

DECEMBER 3, 1987

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STATUS OF THE REHABILITATION OF EISENHOWER AND SNELL LOCKS, ST. LAWRENCE SEAWAY

THURSDAY, DECEMBER 3, 1987

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT,
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:06 a.m., in room 2167, Rayburn House Office Building, Hon. James L. Oberstar [chairman of the subcommittee] presiding.

Mr. OBERSTAR. The Subcommittee on Investigations and Oversight will come to order.

The Chair would like first to take the occasion of the opening of this hearing to acknowledge more than 25 years of service of one of our dedicated, devoted staff members, Shirley Novotny, who was with this subcommittee from nearly its inception and who will be retiring from the subcommittee and the full Committee on Public Works and Transportation at the end of this year. I acknowledge her retirement with great regret. She carries with her an enormous wealth and storehouse of knowledge and professional commitment and dedication to the purpose of this subcommittee, one of the most thoroughly dedicated professional staff members I have known in my 25 years' service in Washington. This will be her last hearing of this subcommittee unless we have one more before the end of the session, and I would like to take this opportunity, Shirley, to say thank you from a very grateful heart, for myself and for my predecessor, John Blatnik, in Congress whom you started here with, and for other members of the subcommittee. It is work that largely goes unheralded, known to a few, but profoundly and deeply appreciated. We wish you all the very best of everything, well deserved, in your years ahead.

We do have a vote in progress on the House Floor, and perhaps before leaving we could make opening statements and then come back and hear the witnesses.

Chairman Howard is with us this morning. Does the chairman have opening remarks?

The CHAIRMAN. No, Mr. Chairman.

Mr. OBERSTAR. This morning the Subcommittee on Investigations and Oversight renews its inquiry into the status of the rehabilitation of the St. Lawrence Seaway locks, but from a different perspective. When we held our first hearing July 15 this past summer, all agencies agreed that the Eisenhower and Snell Locks at Mas-

sena, New York needed rehabilitation. No one claimed they were in imminent danger of collapse. Yet, the Corps of Engineers and the Department of Transportation and the St. Lawrence Seaway Development Corporation, as well as their consultants, all agreed that the locks did have serious stability problems. The only issues last summer were how extensive was the problem and which agency should pay for the rehabilitation.

At the direction of this committee, the two departments, Transportation and the Army, were to compare notes, resolve differences, and report back in 60 days. Subsequent to that hearing, the Corps conducted further analyses, reversed itself, and declared:

> It is the position of the experts in the Corps that both locks are stable against overturning and sliding and, therefore, no remedial measures for stabilizing the lock walls are needed at this time.

The Corps based its reevaluation apparently at least in part on a one-day site visit to the locks, locks that still were filled with water, and in part on existing data which the Seaway Development Corporation and its consultant interpreted to indicate need for rehabilitation, and in part on preliminary results of an ongoing Corps research program into lock stability.

The subcommittee will review the Corps' position on two levels. First, we will review the decision as it affects the Seaway locks. These locks are located at the beginning of the 2300-mile Great Lakes St. Lawrence Seaway system. By designation of the Merchant Marine Act of 1970, it is America's fourth seacoast, one shared by the United States and Canada.

The Eisenhower and Snell locks belong to the United States. The other 12 Seaway locks belong to Canada. There is no way around these two locks. If they are shut down, no ship gets in or out of the Seaway system. If one should fail, the entire system closes. That could cause up to $500 million in economic damage to the region and to the Nation.

The Corps' Buffalo District in a 1984 reconnaissance report found that the locks had stability problems and recommended rehabilitation. The DOT Inspector General in a November 1986 audit report said that delaying rehabilitation "may result in a Seaway shutdown" and recommended the Seaway Development Corporation pursue funding through DOT or the Corps of Engineers.

The Seaway Development Corporation's own consultants, Gannett Fleming Geotechnical Engineers, also identified stability problems and recommended prompt rehabilitation. Now the Corps, using the same existing data, has declared the locks stable against overturning and sliding, claiming that its criteria in the past were too conservative.

The subcommittee will inquire whether this is a sound decision.

Mr. HOWARD. Mr. Chairman, I hate to interrupt, but if I might, we do have a vote going on. I think it's very important—I would like to have a conversation on the way over with you and Mr. Clinger and our counsel. I wonder if we might be able to break now so that I would have the time to talk with you at that time. I hate to interrupt your talk, but I'm afraid if we wait too much longer, we're either going to miss the vote or I'm going to miss my conversation with you. I don't want to do either.

Mr. OBERSTAR. There is no thought so important that it cannot be interrupted by the chairman of the full committee. [Laughter.]

The subcommittee stands in recess.

[Recess taken.]

Mr. OBERSTAR. The subcommittee will resume its sitting.

The subcommittee wants to inquire today and pursue with some vigor whether the Corps' decision that past criteria were too conservative is, in fact, a sound decision, especially given the strategic location of the Seaway locks and the magnitude of the damage that would occur should something happen within those locks that would cause the Seaway to shut down. We want to know whether overturning and sliding are the locks' only problem and whether past criteria for evaluating locks were in fact too conservative, because, frankly, the consequences are so far reaching for this major, inland waterway navigation route as well as for the entire inland navigation system of the United States under the management of the Corps of Engineers.

If criteria are changed here for the Seaway and for its locks, they are going to be changed for locks elsewhere, and we need to know now what are going to be the consequences of that action.

Secondly, the Corps apparently reached its decision at least in part through preliminary research results that are part of a comprehensive Repair Evaluation, Maintenance, and Rehabilitation research program. The Seaway locks are the first to be affected by information resulting from this review, but they are not going to be the only structures to be redefined as "sound" and in need of no further rehabilitation. There will be others to follow.

So we need to hear about the research program that is underway and which other water resource structures may be affected by this reevaluation and redetermination of criteria, and the extent to which that research may be cost driven and not based upon sheer sound engineering judgment.

Now the subcommittee has no reason to believe—and no one has suggested—that the locks are in imminent danger of collapse. The point is we don't know when they might reach that stage. If criteria are changed, we may not be in a position to make sound judgments about future rehabilitation work to prevent such disaster.

I also must wonder aloud whether the Corps' pronouncement on overturning and sliding may have precluded in the minds of other agency officials further needed repair work and rehabilitation.

We all need to stop a moment and remember the collapse in the Welland Canal of a couple of years ago when the huge monolith slipped some 70 feet out into the lock, shut the Seaway down, and the economic tragedy that results for shippers, for producers, for the ports throughout the Great Lakes system, to realize that any such occurrence again in the Seaway might well cause a serious lack of confidence in it.

I say I don't have any information in hand, but I think it's time now to raise the questions, to sound the warning bell that we need to take a very, very careful look before we proceed in making determinations on the basis of draft preliminary studies.

It appears that the Corps has developed a way to reprocess the numbers in order to pronounce the Seaway locks stable against potential problems of overturning and sliding. If any such occurrence

should happen in the wake of the decision that would otherwise remain unchallenged, it certainly should be very clear whose responsibility it is for having made that decision. I don't want to look back in two, three, five, ten years from now and say we should not have allowed that judgment to go unchallenged; we should not have stood by and without questioning whether those criteria changes were in the best interest of navigation.

The Chair recognizes the gentleman from Pennsylvania for an opening statement.

Mr. CLINGER. Thank you very much, Mr. Chairman.

Today's hearing marks the second time in the last six months, as you've indicated, that the subcommittee will review the St. Lawrence Seaway Development Corporation and the U.S. Army Corps of Engineers' plans for the rehabilitation and repair of the Eisenhower and Snell locks on the St. Lawrence Seaway near Massena, New York. I don't believe, however, that any of us expected a second hearing of this nature. Following the two agencies' initial appearances in July, I think we on the subcommittee anticipated receiving a joint report from the Corporation and the Corps with a mutually-agreed-upon cost estimate and timetable for the rehabilitation work on the two locks, that seeming to be the only issue that was really in dispute—the cost that was going to be involved in rehabilitation.

Instead, what we are faced with is a situation in which the Federal Government's lead construction agency now says the remedial work for stabilizing the lock walls is not necessary and the management entity is left to fret over that decision and bear the consequences should the engineering estimates be incorrect.

The purpose, therefore, in meeting today is to examine in detail the Corps' conclusions and the rationale behind them. I'm not a civil engineer; I don't believe you are, Mr. Chairman, and I don't know that we have any such qualified individuals as members of this subcommittee, so it's certainly not our role to substitute our engineering judgment for that of the acknowledged experts. At the same time, recognizing that there are honest differing opinions in the engineering sciences, the subcommittee hopes to examine these differences and reconcile them if at all possible, in order that we may better assess the risks attendant to whatever the ultimate decision is regarding the rehabilitation of Eisenhower and Snell locks.

The subcommittee is quite well aware of the magnitude of the economic consequences should either or both of the two locks collapse or otherwise fail. The record of our July hearings is replete with facts and figures regarding the impacts which would result from the closing the Seaway system for, it's anticipated, up to a year's time.

At the same time, as everyone well recognizes, this is not exactly a time in which the United States Government can afford to spend money needlessly in the prevention of problems which prudent persons would agree have little, if any, probability of ever occurring. But the subcommittee, I think clearly needs to be assured that the current conclusions by the Corps reversing its early position are driven by sound engineering analysis and not by budgetary concerns.

My understanding of basic civil engineering principles is that structural engineering decisions are generally based upon very conservative design criteria that minimize, if not totally eliminate, the prospect of catastrophic failure. Certainly if it were solely the choice of this committee and the Congress, a decision regarding the rehabilitation of the Eisenhower and Snell locks would similarly err on the side of caution.

At the conclusion of today's hearing, I would hope that we can be assured that that sense and decree of caution has not been abrogated in the Corps' recommendation regarding the need for that rehabilitation work.

I thank you, Mr. Chairman, for calling the hearing and look forward to hearing the testimony.

Mr. OBERSTAR. I thank the gentleman for his remarks.

The gentlelady from Maryland?

Mrs. BENTLEY. Thank you, Mr. Chairman.

Mr. Chairman, I ask unanimous consent to have some formal remarks included.

Mr. OBERSTAR. Without objection, so ordered.

[Mrs. Bentley's prepared statement follows:]

Rep. Helen Delich Bentley

Opening Statement Before the

Subcommittee on Investigations and Oversight

December 3, 1987

Chairman Oberstar and Mr. Clinger, I commend both of you for calling this oversight hearing together to review the Army Corps of Engineers' study of the rehabilitation of the Eisenhower and Snell Locks. Maintaining a safe and sound infrastructure of the St. Lawrence Seaway is vitally important to a significant percentage of the nation's economic trade balance.

As a member of this subcommittee, I have been actively involved in oversight hearings to review several segments of our nation's infrastructure. Today we will receive testimony concerning our inland waterways infrastructure. I look forward to hearing from the Army Corps of Engineers provide their testimony before the subcommittee.

When I was working as a newspaper journalist, I had the opportunity to visit the St. Lawrence Seaway and walk near the locks during an on-site inspection of the locks. This occasion provided me with a first hand knowledge of the conditions of the navigation structure. I am sure that significant structural changes have occurred since my visit.

It has been reported that the Eisenhower and Snell Locks have operated and been dewatered many times during their service life without stability problems. The St. Lawrence Seaway Development Corporation has demonstrated an excellent financing scheme in regard to the locks over the past twenty years.

I offer my attention and full support in reviewing the testimony presented here today. Working closely with the Army Corps of Engineers, we in Congress can help effectively implement legislation designed to maintain our national infrastructure.

Mrs. BENTLEY. I have a great deal of interest in this project. I'm one of those who walked along the shores of the locks when they were being built in 1956 and was there for the dedication in 1959. As I've told you repeatedly, I was one of those who fought the Seaway, but now that we have it, we have to keep it operating. I think this hearing is very important to find the why's and wherefore's. Thank you.

Mr. OBERSTAR. That institutional memory is so important in our work. I thank the gentlelady for those remarks.

Not a member of this subcommittee or the full committee, we nonetheless have invited to participate with us this morning and will recognize for opening remarks Congressman David O'Brien Martin of upstate New York, through whose front yard the seaway runs.

Does the gentleman have opening remarks?

Mr. MARTIN. I want to thank you very much, Mr. Chairman, for inviting me, and the ranking member as well. This is a subject of enormous economic interest to the people in the Midwest, the North, and along the St. Lawrence River.

We don't derive the economic benefit directly from the Seaway in northern New York that others would, say, in North Dakota or Minnesota or Pennsylvania, in the sense of ships stopping by our ports, but we're very proud of the fact that we have an outstanding organization, a group of employees who are responsible for operating all of the American locks; namely, two: Eisenhower and Snell. We do it very well, and we are very proud of it. We understand the enormous responsibility we have of keeping that waterway open because of the economic consequences to the Midwest.

Now while the Seaway might be 2300 miles long, as a very practical matter, it's only about 80 feet wide. If any one of those locks should be shut down, as the chairman pointed out, it would be an economic catastrophe for the people, particularly in the Midwest.

I want to reflect on what the ranking Republican of the subcommittee had to say about our background, as far as being civil engineers or architects. Most Members of Congress are perceived to be expert economists, and we conduct foreign policy in about 435 different directions in our body and 100 in the other body, and we're also master military tacticians, but we're going to have to today focus our attention on architecture and civil engineering. We wait with baited breath for an explanation as to how this reevaluation came about and what the different standards are.

The ranking Republican said that we have to err, if we're going to err, on the side of being conservative to insure that that 80-foot-wide waterway isn't shut down and the life line of the Midwest severed.

I want to thank the chairman very much for inviting me. I hope to be here for most of the day. If I cannot, perhaps staff will be here. I thank you very much, Mr. Chairman and Mr. Clinger, for inviting me.

Mr. OBERSTAR. The Chair will also ask unanimous consent to include in the record at this point the statement from our colleague Carl Purcell. Congressman Purcell of Michigan could not be here today.

[Mr. Purcell's prepared statement follows:]

STATEMENT OF

CONGRESSMAN CARL D. PURSELL

STABILITY OF EISENHOWER AND SNELL LOCKS HEARING

DECEMBER 3, 1987

Thank you, Mr. Chairman for allowing me to submit my statement. I apologize that I could not attend the hearing but my schedule demanded me to be in the district.

As I testified at your last hearing in August, we must not only make sure that the Eisenhower and Snell Locks are workable at all times, we must now give consideration to the modernization of the St. Lawrence Seaway.

The St. Lawrence Seaway has been a vital international transportation link between the Atlantic Ocean and the Great Lakes and its hinterland, since its opening in 1959. In those 27 years over one billion tons of cargo have moved through each of the locks in the seaway. Each ton has done so in a more energy and cost-efficient manner than by any other mode of transportation.

We are now at a point where we not only have to look at the short-range needs, but we must look at the long-range needs of the seaway as well. My objective is full modernization of the entire St. Lawrence Seaway. Decisions on building new locks and their size would be in conjunction with international agreement with Canada. My goal is to improve the competitive position of the Midwest in national and world trade and to create expanded business and job opportunities throughout the Great Lakes.

Modernization of the bi-national St. Lawrence Seaway is an important factor in realizing the economic potential of the Great Lakes region in coming years. It is a critical component for improving our region's competitive position in national and international trade.

For the record, I would like to submit a list of funds expended for extraordinary maintenance of the Eisenhower and Snell Locks.

FUNDS EXPENDED FOR EXTRAORDINARY MAINTENANCE OF EISENHOWER AND SNELL LOCKS

Historical Repair Costs.

Note: All repairs are at Eisenhower Lock except those as indicated for Snell Lock.

Fiscal Year	Repairs	Cost
1959	Repairs to culvert valve anchorages	$2,000
1960	Repairs to culvert valve anchorages and upper sill	$198,000
1961	Repairs to upper sill. Pinning of upper sill at Snell Lock	$290,000
1962	Lower sill emergency repairs	$163,000
1963	Damaged lower sill removed and replaced. Concrete repairs in culverts	$142,000
1964	Concrete repairs in culverts	$53,000
1965	Concrete repairs in culverts	$124,000
1966	Concrete repairs in culverts and vertical lift gate slots	$214,000
1967	Sealing of highway tunnel and concrete repairs in culvert. Extensive concrete condition survey.	$174,000
1968	Post-tension culvert cracks and concrete repairs to sill intake manifold, highway tunnel & N 54.	$4,454,000
1969	Repairs to concrete in culvert & chamber walls. Snell Lock, post-tension culvert cracks.	$4,180,000
1970	Post-tension gate monolith S 32	$189,000
1971	Snell Lock, post-tension gate monolith S 27	$134,000
1972	Repairs to culvert floors in intake area	$44,000
1973	Repairs to diffusers	$148,000
1974	Concrete repairs to downstream gate recesses	$242,000
1975	Concrete repairs in vertical lift gate area and post-tension upper sill. Snell Lock, concrete repairs to crowns of intakes.	$235,000

1977	Concrete repairs upper sill culverts & chamber walls	$386,000
1978	Concrete repairs in culverts, chamber walls & lower sill	$306,000
1979	Concrete repairs to lower sill & chamber walls	$336,000
1980	Concrete repairs to chamber walls & in culverts	$462,000
1981	Concrete repairs to chamber walls	$723,000
1982	Concrete repairs to chamber walls	$681,000
1983	Concrete repairs to chamber walls	$974,000
1984		None
1985		None
1986	Concrete repairs to chamber walls	2,140,000
1987	Concrete repairs to chamber walls	1,997,000*
	Total	$19,267,000

*Appropriated funds

[Mr. Stangeland's prepared statement follows:]

STATEMENT OF HONORABLE ARLAN STANGELAND

BEFORE INVESTIGATIONS AND OVERSIGHT SUBCOMMITTEE

REGARDING EISENHOWER AND SNELL LOCK REPAIR

DECEMBER 3, 1987

THANK YOU, MR. CHAIRMAN. I COMMEND YOU FOR HOLDING TODAY'S HEARING ON RECENT ENGINEERING ANALYSES BY THE CORPS OF ENGINEERS AND ON REHABILITATION OF THE ST. LAWRENCE SEAWAY'S EISENHOWER AND SNELL LOCKS. ONGOING CONCERNS, RECENT DEVELOPMENTS, AND CONFLICTING REPORTS MAKE THE SUBCOMMITTEE'S HEARING EXTREMELY VALUABLE AND TIMELY.

FIRST, LET ME WELCOME BACK THE DISTINGUISHED ACTING ASSISTANT SECRETARY OF THE ARMY FOR CIVIL WORKS, JOHN DOYLE. UP UNTIL A YEAR AGO, JOHN COULD BE FOUND WORKING DAY AND NIGHT WITH ME IN THE ROOM UPSTAIRS, PERFORMING HIS DUTIES AS MINORITY COUNSEL FOR THE WATER RESOURCES SUBCOMMITTEE. PROBABLY NO ONE UNDERSTANDS THE BACKGROUND, NEED AND INTENT OF THE WATER RESOURCES DEVELOPMENT ACT OF 1986 AS WELL AS JOHN DOES. HE KNOWS THE PARTICULARS OF THE EISENHOWER AND SNELL LANGUAGE AUTHORIZING REHABILITATION WORK, SINCE HE HELPED CHAIRMAN OBERSTAR AND ME WRITE THE PROVISION. IT'S GREAT TO SEE YOU, JOHN.

IN JULY, THE SUBCOMMITTEE HEARD FROM THE CORPS, THE DEPARTMENT OF TRANSPORTATION, AND THE ST. LAWRENCE SEAWAY DEVELOPMENT CORPORATION ON THE STATUS OF REHABILITATION WORK FOR THE EISENHOWER AND SNELL LOCKS, AUTHORIZED IN SECTION 1163 OF THE NEW OMNIBUS WATER RESOURCES LAW. WE WALKED AWAY FROM THAT HEARING WITH THE FOLLOWING UNDERSTANDINGS. FIRST, REHABILITATION

WORK--EITHER TO ADDRESS DETERIORATED CONCRETE OR LOCK STABILITY PROBLEMS--SHOULD BEGIN AS SOON AS POSSIBLE, ALTHOUGH WE REALIZED THE LOCKS WERE NOT IN IMMINENT DANGER OF COLLAPSE. SECOND, THE CORPS AND THE DEPARTMENT OF TRANSPORTATION WERE TO REVIEW THE CORPS' BUFFALO DISTRICT REPORT AND THE PRIVATE CONSULTANT'S REPORT AND RECONCILE THE DIFFERENCES.

TODAY'S HEARING, OF COURSE, IS A FOLLOW-UP TO THE JULY HEARING AND A RESPONSE TO RECENT DEVELOPMENTS. BASED ON THEIR REPAIR, EVALUATION, MAINTENANCE AND REHABILITATION RESEARCH PROGRAM AND NEWLY DEVELOPED CRITERIA FOR EXISTING CONCRETE NAVIGATION STRUCTURES ON ROCK, THE CORPS NOW BELIEVES THE EISENHOWER AND SNELL DO NOT NEED ANY REHABILITATION WORK TO STABILIZE THE LOCKS.

FOR ME, THIS CHANGE IN POSITION CAUSES TWO CONCERNS: ONE IS LOCAL OR SITE-SPECIFIC; THE OTHER IS NATIONAL. THE SITE-SPECIFIC CONCERN I HAVE INVOLVES THE IMPACT ON THE TWO LOCKS AND THE ENTIRE ST. LAWRENCE SEAWAY SYSTEM, LINKING AMERICA'S AGRICULTURAL AND INDUSTRIAL HEARTLAND TO THE REST OF THE WORLD. SINCE REGIONAL ECONOMIES OF THE U.S. DEPEND SO HEAVILY ON THIS "GATEWAY TO COMMERCE," WE MUST ENSURE THAT EACH AND EVERY COMPONENT REMAINS IN OPTIMUM WORKING ORDER. IT'S SIMPLY TOO COSTLY TO GOVERNMENT AND COMMERCE IN THE LONG RUN IF NEEDED REPAIRS ARE DELAYED FOR SHORT-SIGHTED BUDGETARY REASONS. I TRUST THAT IS NOT THE CASE IN THIS INSTANCE, BUT I NEED TO BE REASSURED. IN ADDITION, I NEED TO KNOW WHAT THE CORPS' VIEWS ARE ON CONCRETE DETERIORATION, AS OPPOSED TO LOCK STABILIZATION, AT THE LOCKS.

I ALSO HAVE CONCERNS ABOUT THE NATIONWIDE IMPACT OF THE CORPS' NEWLY DEVELOPED STABILITY CRITERIA FOR EXISTING CONCRETE STRUCTURES ON ROCK FOUNDATIONS. GIVEN THE LARGE NUMBER AND OLD AGE OF CORPS' LOCKS ACROSS THIS COUNTRY, WE MUST HAVE AN AGGRESSIVE MAINTENANCE AND REPAIR PROGRAM. BEFORE FINALLY IMPLEMENTING SUCH A FAR-REACHING PROPOSAL, I WOULD HOPE THE CORPS SEEKS THE VIEWS OF INFRASTRUCTURE SPECIALISTS, WATER RESOURCES AGENCIES, THE INLAND WATERWAYS USERS BOARD, AND OTHERS.

MR. CHAIRMAN, FOR ALL OF THESE REASONS I LOOK FORWARD TO REVIEWING TODAY'S TESTIMONY.

Mr. OBERSTAR. Our first witnesses are the Honorable John Doyle, Jr., Acting Assistant Secretary of the Army for Civil Works, and the Honorable James L. Emery, the Administrator of the St. Lawrence Seaway Development Corporation.

Please come forward.

Raise your right hand.

[Witnesses sworn.]

Mr. OBERSTAR. Mr. Doyle, we welcome you to the committee. In a sense, we welcome you back in a new capacity. You are quite accustomed to sitting at that table from your previous career, but in a very different capacity, as one of the prized senior professional staff members of this full Committee on Public Works and Transportation. We always take great pleasure in former members and staff members of the Public Works Committee going on to new challenges and new opportunities. We commend you and welcome you to this hearing.

TESTIMONY OF HON. JOHN S. DOYLE, JR., ACTING ASSISTANT SECRETARY OF THE ARMY FOR CIVIL WORKS, DEPARTMENT OF THE ARMY; AND HON. JAMES L. EMERY, ADMINISTRATOR, ST. LAWRENCE SEAWAY CORPORATION

Mr. DOYLE. Thank you, Mr. Chairman. It's a true pleasure for 10 years' worth of reasons to be able to be back here in this room with all of you and with the staff.

I must mention on the record, however, the discussion that we had earlier. The view is different from down here than it is from up there. But it's a treat to be here with this committee that has so much interest and so much expertise in the Nation's waterways.

I have with me today from the Office of Chief of Engineers Mr. Lloyd Duscha, the Deputy Director of the Engineering and Construction Directorate; Mr. Robert Smith, who is the Chief of the Structures Branch; Mr. Richard Davidson, the Chief of the Soils Mechanics Section; Dr. G. Edward Dickey, who's Deputy for Program Planning, Review and Evaluation in my office; and Mr. Jesse Pfeiffer, who is with the Research and Development Directorate of the Corps of Engineers.

With your permission, sir, I'd like to submit my formal statement for the record and summarize. Then I'd be more than happy to take any questions that you and your colleagues would have.

Mr. OBERSTAR. Without objection, the testimony will be included in full in the record, and you summarize as you choose.

Mr. DOYLE. I will point to the summary that you gave as being an excellent starting place in terms of the basic facts.

The Corps of Engineers performed a study at the request of the St. Lawrence Seaway Development Corporation. It was done at the district level. It was a very brief and lightly-funded study, what we would call a reconnaissance-level study. That effort, as you are aware, led to preliminary conclusions that there were stability problems and concrete deterioration problems at the Eisenhower and Snell locks.

That report was never finalized because of funding constraints and because it was overtaken by events. The conclusions that were reached in the report were based on engineering criteria that the

Corps was applying at the time with respect to rehabilitation questions.

At about the same time the Corps initiated the REMR program, the research program which you referred to. We are in the fifth year of that currently-envisioned six-year program.

In April of this year preliminary results were announced in the REMR program of two very important findings with respect to opportunities to adjust criteria based on new analytical capabilities not available 30, 40, and 50 years ago when the original criteria were first developed.

The REMR program was initiated in an effort to begin to prepare us and you to face the reality that by the year 2000 roughly 40 percent of our locks and dams throughout this country will be beyond the 50-year design life of those facilities, and to take advantage of the opportunities that could be identified based on technological developments since the original criteria were put in place.

Following the July hearing which you held on this subject, as you indicated, we did send a team on site for a day to do as much as they could in that amount of time under the circumstances that they were faced with in terms of the lock operations. Following that site visit, a decision was reached with respect to how to proceed on the Eisenhower and Snell locks; namely that the new criteria that have been developed in the REMR program could and should be applied with respect to making funding prioritization decisions as to whether immediate expenditures were proper with respect to those two locks. That process led to communications that you and Secretary Dole received in the month of September, basically stating that fact and providing some explanation for how those conclusions were reached.

In essence, what we have, in my opinion, is a situation of new engineering developments, first and, second a very legitimate disagreement among engineering professionals as to which engineering criteria should be applied for purposes of making the investment decision that represents the subject of this hearing.

The Corps of Engineers and their experts are convinced that the position reflected in the documents that you have that apply the new criteria is the proper place for us to be with respect to that investment decision, and the very excellent engineers that were retained by the St. Lawrence Seaway Development Corporation share a different view. That, in essence, is the basis of the disagreement that we have, in my understanding.

Thank you, sir.

Mr. OBERSTAR. Thank you, Mr. Doyle. We will have questions for you later.

Mr. Emery, we welcome your statement. We want to thank you for taking the time to be here with us. I'd like to take this opportunity also to commend you on the splendid job you have done on behalf of the St. Lawrence Seaway Development Corporation under some very difficult circumstances and at sea tide change of operations for the Seaway Authority, as directed in the Water Resources Act, H.R. 6.

You've provided splendid leadership, and I think that is a matter of record for Members of Congress from the Great Lakes region.

Mr. EMERY. Thank you, Mr. Chairman. Let me thank you for the opportunity to appear before you and your colleagues, and especially my good friend Congressman Dave Martin, whom you know I served with in the New York State legislature in New York for a number of years.

Prior to my remarks, I would like to note for the record that with me today—this just happened to be our advisory board quarterly meeting—is the chairman of that board, Steve Reimers from North Dakota—they're all sitting to my right—Virgil Brown, a county commissioner, Cayahoga County, Ohio; Mack Fredin, whom I don't have to introduce to you, a constitute and attorney from Duluth, Minnesota; and Leo McKenna, who just briefly was here with us earlier and has left, who is from New York; and a designee to the advisory board, Mr. Randolph Agley from Detroit, Michigan. They are here with us today.

Mr. OBERSTAR. I would like to welcome all the members of the advisory board—excuse me, Mr. Emery—and invite you to sit through the hearing, if you have the patience. It will be long and detailed.

I would like especially to take this opportunity to welcome to the hearing an old friend personally, Mr. Fredin, who is not only a distinguished lawyer and a former president of the Minnesota Bar Association, but notably a friend of the Seaway, one who has been its advocate since before it existed.

Mr. EMERY. Thank you, Mr. Chairman—and a very valued member of our board as well, and we draw upon his historical memory on many, many occasions to tell us why we are even here to exist in the first place. We appreciate his counsel.

I would like to offer my entire statement for the record and I will paraphrase some of those things that are in that as I give my statement, and then would certainly be available for questions.

Mr. OBERSTAR. Without objection, the statement will be included in the record in full.

Mr. EMERY. One of the things, Mr. Chairman, that you and your colleagues suggested shortly after my appointment was to make a thorough review of the Corporation's physical assets and management to assess what changes, if any, were needed to insure the safe, efficient transit of Seaway vessels through the system. There appeared to be two problems with the structural integrity. First, the long problem of deteriorating concrete, which between 1959 and 1983 the Corporation spent nearly $10 million to remedy. Indeed, I should point out that every winter when we covered those locks it was an expenditure of $250,000 merely to cover and heat them.

The second problem of the locks was their structural stability. In 1967 cracks in the culverts were discovered at both Eisenhower and Snell locks. In 1968 and 1969 over $5 million was expended for post-tensioning to remedy the problems at Eisenhower and Snell locks. The Corps of Engineers' board of consultants, after reviewing the work done to correct the culvert cracks, felt the necessary repairs had been completed satisfactorily.

In 1980 the Corporation hired Harza Engineering Company of Chicago, Illinois to prepare an engineering survey on Eisenhower and Snell locks. Their major findings were as follows:

Concrete: No problem was found at Snell; deteriorating concrete at Eisenhower was found to still be a significant problem. They recommended continued concrete resurfacing to correct the problem.

Structural: Using the high observed water levels and the same earth pressure assumptions used by the original designers, Harza found that overturning stability of the locks was unacceptable. The report indicated required repairs would consist of an anchoring system at a cost estimate of about $6.5 million.

The work, however, at that time was not recommended because of the poorly-known properties of the backfill which were used to compute earth pressure. A program of additional soils exploration and testing was recommended, and in 1981 the Corporation contracted with Empire Soils to conduct those limited soils test. The results of those tests substantiated the findings of the Harza investigation.

In June of 1984, at my direction, personnel from the Corps of Engineers' district office met with our engineers in Massena and were briefed on the concrete deterioration and lock wall stability problems. The Corporation prepared a report on the remaining extraordinary repairs required to the locks, and this report, along with other technical data, was delivered to the Corps on August 30, 1984, and we then subsequently entered into an agreement with the Buffalo District repair recognizance report on major rehabilitation at Eisenhower.

In February of 1985 the Buffalo District issued their report recommending major rehabilitation was required; the total cost has already been stated of $39 million for concrete deterioration, lock wall stabilization, and other minor repairs. The report noted that, because of the urgency of the repairs, the work is scheduled to be initiated in the winter of 1985–86.

It should be noted that the economic impact that you mentioned of $500 million which was mentioned in that report, if we take that one step further and look at the problems that it has caused the Canadian Government, the Seaway Authority of Canada, because of the shutdown of the Valley Field Bridge a couple of years ago and then at lock 7 at the Welland Canal, they have lawsuits totaling some $50 million against them yet to be settled.

The Corporation response to the Corps of Engineers' report was to first tackle the problem of concrete deterioration. Rather than continue the piecemeal approach of concrete repair, the Corporation decided to finish this work in a two-year period. We undertook this in 1985–86, taking over $2 million from our reserves to do the first phase and then, thanks to you and Congressman Purcell and others, you appropriated $2 million in 1986–87 to finish that concrete repair job.

The Corporation now no longer has to pay $250,000 a year to cover and heat the locks. In conclusion, the deteriorated concrete on the lock walls has been remedied, in our opinion.

The second step was lock wall stability, how do we address that? In January of 1986 the Corporation retained Professor Alan Lutenegger of Clarkson University in Potdam, New York; to review all pertinent data: the Corporation data, the Harza report, the Corps report to reconfirm whether a detailed engineering study was required and, if required, to prepare the work statements for A&E

services. He filed a report with the Corporation and indicated that there were lock wall stability problems at both locks, and that we should seek bids to perform detailed engineering and design.

In May of 1986 the Corporation awarded a contract to Gannett Fleming Geotechnical Engineers of Harrisburg, Pennsylvania to prepare a report on the extent of the problem and alternative means of accomplishing the work. Gannett Fleming has been in Massena all of last summer—excuse me, the summer of 1986—when they issued a preliminary report which indicated there was, indeed, a problem and recommended the most cost-effective approach: concrete struts in post-tension anchors be pursued to increase the safety factors.

During the winter we completely dewatered the lock at Eisenhower and in May of 1987 final plans and specifications and a cost estimate of $7.5 million was prepared to improve that stability at Eisenhower lock. The final stage at the Snell lock will be done this year during the winter months shutdown, January to April, when we'll dewater Snell lock and they'll furnish us a complete report of that experience.

At that time the Corporation provided the Great Lakes Congressmen, the Appropriations Committee, the Office of the Secretary and OMB with the Gannett Fleming reports and furnished copies of that report to the respective offices of the Corps of Engineers.

Public Law 99-662 of 1986 authorized up to $39 million for stability improvements. In addition, Mr. Chairman, you and 26 other Congressmen requested the Senate to fund the Eisenhower rehab in Fiscal Year 1988. We did request bids on that work in October of 1987 in the event that funding was available. We received the bids. Our estimate was $7.5 million; the bids ranged from $8.7 million to $12 million to do the work required in the Gannett Fleming engineering design. I believe the reason for the higher bids is probably due to a massive $500 million construction project at Ft. Drum which is located 90 miles from Massena. There is no longer a need for a great deal of winter work in that area.

Mr. Chairman, as I said at the beginning of my testimony, the physical dependability of the locks has been a top priority of my tenure at the Seaway head. In addition to addressing the major rehab items of concrete deterioration and lock stability, the Corporation in 1984 put in place the first five-year, a rolling capital plan and beefed up the maintenance program. Since then, the five-year plan has been updated annually. It's intended to be a living document to assist management in the budget process and to provide guidelines in scheduling capital improvements.

The total capital outlay since 1984 in that program has been nearly $5 million. The major projects were a vessel traffic control center modernization; replace and improve lock facilities; improve guide wall extension at both locks; improve fendering systems at both locks; building rehabilitations and improvements; navigation aid improvements; and replacement of capital equipment in excess of $1 million, which includes, I might point out—thanks to the ingenuity of people who work for the Corporation, we acquired two hopper barges from MARAD for dredging at well below market cost, and we've acquired a surplus buoy barge for our navigation aid operations, which would have required a $500,000 outlay.

We have prepared a Seaway contingency plan with an engineering firm awarded in Syracuse, New York to prepare a plan to paraphrase that slogan on television, "a what-if situation"—what if this happened; what if that happened? That plan is now complete. We have it in our hands. We're able to readily address any emergency situation at either lock or in the river.

The plan is particularly valuable because, as Congressman Martin is aware, we're in rather a remote area of New York State and that plan identifies the types of special internal and external manpower skills that might be required under different circumstances as well as special equipment for rapid deployment from within a 200-mile radius of Massena.

Since 1984, the Corporation has initiated a beefed-up maintenance program which includes the completion of concrete repair of lock walls at Eisenhower and the initiation of a comprehensive, computerized, preventative maintenance program. Starting in January of next year, our foreman will be able to go in every week and will receive from the computer that work that has to be done in that week, and that will be done throughout the year.

The Corporation is planning to spend approximately $20 million in the next five years to carry out the capital improvement and maintenance programs. The current five-year capital plan projects expenditures of $12.5 million. I would like to point out also that the Fiscal Year 1987 expenditures of the Corporation of $7.5 million were $500,000 less than we incurred in Fiscal Year 1983. That's on the operations side, and we have used that money in the capital side. The maximum use of corporate cash, coupled with several management improvements that we initiated that resulted in recurring savings of $1.5 million, has enabled the Corporation to maintain an invested financial reserve of $10 million to deal with unanticipated events which might interrupt shipping on the seaway.

Through the efforts of our employees and managers during the past four years, $5 million was expended for plant and equipment and $2 million was expended for extraordinary concrete repairs.

Finally, we have a financial reserve fully invested as of October 1, 1987 equal to the total cash on hand when I came in to this office on September 30, 1983. The beefed-up capital program as well as concrete repair in 1986 were accomplished at the same time tolls were frozen at 1983 levels for five years.

I might also point out, Mr. Chairman, that the Canadian Government, recognizing the problems that they have on their side, have embarked on a $175 million Canadian seven-year program to rehabilitate and improve the Welland Canal. It should be noted that these funds are a direct appropriation to the St. Lawrence Seaway Authority and they will not be recouped through the toll structure.

Finally, Mr. Chairman, although the hearing does not address the issue of toll retention, it should be noted, had the Corporation continued access to the tolls, it could have financed the rehabilitation of Eisenhower lock from its financial reserves and remaining bonding authority and still retained a sufficient reserve to meet continued unanticipated events.

I have with me today Steve Hung, the Corporation's Chief of Engineering, and Jim Knight, the president of Gannett Fleming who

are here to respond to any technical questions that you or the committee may have.

Thank you, Mr. Chairman.

Mr. OBERSTAR. Thank you, Mr. Emery. We appreciate that review of the status of maintenance work and other technical issues affecting the seaway locks.

Mr. Doyle, could you provide for the committee a description in a little more detail of the purpose of the Research Evaluation, Maintenance, and Rehabilitation research program and what its goals are, when it is due to be completed?

Mr. DOYLE. The REMR program, if I can use that shorthand term rather than repeating the full title——

Mr. OBERSTAR. Remer is a city in my district, by the way. [Laughter.]

Mr. DOYLE [continuing]. Was designed initially as a six-year, focused-attention effort to begin to look more concertedly at the investment decisions that we jointly will have facing us in the Federal Government with respect to our civil works projects nationwide as they move into the final years and beyond the final years of their original design life, which in most cases was a 50-year period. It is an effort to ask the following questions and to answer them in as many ways as possible—to what extent has technological development progressed to the point that we are able to better identify what the rehabilitation needs are of those older lock and dam facilities and what new and more cost-effective mechanisms may have recently been developed to help us address any needs identified? It was to begin to prepare us to make the investment decisions that will need to be made in the future and do it in a more cost-effective and engineering way.

Mr. OBERSTAR. When is the REMR study due to be completed?

Mr. DOYLE. We are in the fifth year, so it will be one year after Fiscal Year 1988 or at the end of Fiscal Year 1989.

Mr. OBERSTAR. The results, then, of this study, once it's gone through—will that have to go through the board review as projects do or will this——

Mr. DOYLE. No, sir. This is not the typical feasibility study process that we have for any specific project. It's a programwide research effort. Now I believe there may be some board input. I would be surprised if there were not some opportunity for the experts at the board to be able to review periodically the developments of the project. There are periodic reports that are sent with respect to major developments of the program, but it doesn't follow the traditional feasibility report process.

Mr. OBERSTAR. When completed and if approved by the Chief of Engineers and the Secretary, Assistant Secretary for Civil Works, will the recommendations and the conclusions form the basis for new policy for the Corps for all inland waterways?

Mr. DOYLE. I'm going to answer exactly the question you asked—I, of course, won't know that answer, neither of us will, until we get to 1991. My expectation is now that it will be the basis for new policy. The subject of this hearing, in fact, is a manifestation of a programwide policy change that has been made as a result of the REMR program to date.

Mr. OBERSTAR. So even before completion of the study, the Corps will be implementing interim findings or information that they conclude to be sound, before the final signoff on this study; is that right?

Mr. DOYLE. That is correct insofar as the findings of the effort are established to a great enough degree of certainty to support a policy change.

Mr. OBERSTAR. Will the policy changes such as are the subject of this subcommittee hearing apply to the nine new lock and dam projects authorized in H.R. 6: Oliver lock and dam, Alabama; Lock and Dams 5–14 in Kentucky; Gallipolis; Bonneville; Lock and Dam 7 in Pennsylvania; Lock and Dam 8 in Pennsylvania; Winfield lock and dam, West Virginia; the Sault at Michigan; and Lock and Dam 26?

Mr. DOYLE. I expect not, but let me tell you why. Those are all new projects, and by the time they get to their design lifetime you and I are going to be over 100 years old, I expect that there will be further developments that will have occurred with respect to rehabilitation of those locks. These new REMR standards will be applied to, and are currently being applied to, current lock and dam rehabilitation efforts on our Nation's waterways.

Mr. OBERSTAR. But there are elements of the study, as I have looked at it, that could be incorporated into new lock and dam construction. As I read through this draft Phase I preliminary report, "Methods of Evaluating Stability and Safety of Gravity, Earth-Retaining Structures," this report says that we've been too conservative in the past. If we've been too conservative in the past, then there is the possibility that design criteria would be changed to be less conservative.

Mr. DOYLE. I think perhaps what I need to do——

Mr. OBERSTAR. Is new work going to be designed in a different way based on the REMR study?

Mr. DOYLE. I suspect the answer is yes, but for reasons other than the specific criteria that we're talking about here. That's what I was referring to, but maybe the best place to get an answer on that, if it's satisfactory with you, is with the technical panel who's more familiar with the subject.

Mr. OBERSTAR. We'll scope that further.

I want to quote from the introduction to this study:

> A number of existing structures that show no signs of instability or substandard performance have been found not to meet the criteria currently used for design of new structures, and the possibility exists that the combination of the criteria and the methods currently used are more conservative than necessary.

Now I translated that to read: In the past we built them so conservatively, so cautiously, that nothing collapsed. Let's build them less safely in the future.

Mr. DOYLE. I don't——

Mr. OBERSTAR. Let's not put the margin of safety in in the future that we've put in the past.

Mr. DOYLE. Here's how I understand that statement to be read: we have had this research program, which is exactly that, a research program, going on for now more than four years. In addition to that, we have empirical evidence that represents the facts

described by the sentence you read, which supports the conclusion in the research effort that the criteria can safely be changed.

If, for instance, there were empirical evidence of major stability problems in our locks and dams, using our older criteria, then that would argue empirically against the conclusions of the research program. In fact, the opposite is occurring, which would be supportive evidence of the conclusions of the research program.

Mr. OBERSTAR. Well, reading this and all the subsequent material that followed—I don't know logorithms and do calculus, but I looked at all these charts and the formulae that accompany all the design matters described here. I just came to the conclusion that the Corps looked and said, "You know, nothing we've built in the last 50 years has collapsed. We were very conservative in the way we did this thing. Maybe we can save some money in the future by not being so conservative."

Mr. DOYLE. To the extent that that happened—and I'm not in a position to be able to say that it did or didn't—but to the extent that it did, my feeling is that's not necessarily an inappropriate question to ask. In fact——

Mr. OBERSTAR. It may well not be. That may not be the thought process that was gone through. When you look at this thing from the standpoint of this subcommittee, which has looked at safety in pipelines, safety in aviation, safety in bridges, and safety in our highway program, you find some patterns that develop, a thread. For some time the Federal Aviation Administration has said, "You know, we had three controllers sitting in a line looking at screens. Two is probably enough. We can have one clerk sitting up there." The pipeline safety office said, "You know, inspections every year would pick up a lot of problems, but we can do it every two or maybe every five years," and then a pipeline blows up. Now yesterday and the day before we heard about bridge inspections that are being done at increasingly longer intervals, and a bridge collapses.

I have to take the longer and maybe harder view and ask the hard questions. If we don't, I don't know who does. But it's troubling to me.

Mr. DOYLE. Yes, sir; and I fully appreciate that. I am very glad that you are taking that view. It's good for you; it's good for us. That goes without saying, I think.

I think you also know my feeling of respect and consideration for the Corps of Engineers as an institution. No one knows better than you and this subcommittee how highly held that institution is in the engineering community. In my view, it is the finest engineering community that exists in any government in the world. The last thing in the world that I would ever allow myself to do would be to consciously reach a decision that would somehow compromise the reputation of the Corps of Engineers for engineering excellence and for designing and building, or having built, structures which will stand the test of time with an adequate safety margin.

The recommendations that we have before us come from those experts themselves, based on more than three years of research and a conclusion having been reached that we can do a better job and still have an adequate level of safety.

The institution of the Corps of Engineers and all the expertise that's represented therein is what's brought this decision to change

the criteria to us, and that fact, as much as anything else, has helped me feel confident in it.

Mr. OBERSTAR. I appreciate your defense of the Corps, and I have been its defender on many an occasion when the Corps' detractors have attacked the Corps of Engineers. I have worked conservatively. I think that's the reason those structures have lasted. The Romans built conservatively. That's why the Appian Way stands to this very day. That's why the aquaducts of ancient Rome are still in place. That's why contractors in the city of Rome are paid extra to have to dig through foundations built by the Romans. I'd like a future civilization a couple of thousand years from now to say, "By gosh, we ran into a Corps project and we need some extra money to dig through it because it's so well built."

That's why I was surprised to see information in a draft, preliminary report formed the foundation for a recommendation that had the effect of cutting off $18 million of work which scarcely a year and a half earlier was recommended by the Buffalo District office of the Corps.

Mr. DOYLE. May I comment on that Buffalo District report a little bit more?

Mr. OBERSTAR. Yes.

Mr. DOYLE. That, as I mentioned in my summary and in more detail in the written statement, was a very preliminary review. It was a $15,000 study that was done to take a rough cut at the question, using, then, applicable criteria—and it has to be understood in that context. The Gannett study that was done was a $500,000 study that looked at a very narrow part of the question, one of the two issues, in any event, addressed in the Corps report. That needs to be recognized.

Mr. OBERSTAR. Granted. So, then, what we have are two preliminary reports: the preliminary report of the district office and the preliminary report of the REMR study? This is not in ordinary Corps tradition to take preliminary information and apply it in practice. The Corps moves much more slowly and deliberately, in my long experience.

Mr. DOYLE. We have to remember that the Buffalo District report was done on a reimbursable basis for the Corporation to answer the question that was asked by the Corporation under the circumstances that existed at the time. The product turned over to the Corporation because, after all, these are Corporation projects, not Corps projects.

The REMR effort is one that has been a much more longstanding effort and a much more detailed effort involving not just the Corps, but the private sector and the university community as well.

We have made a judgment that the data are persuasive enough, based on the work that's been done, to warrant making the policy change at least until something develops to indicate that that is not the proper position to have us following.

Mr. OBERSTAR. We're getting close to some of the technical aspects of this that I want to reserve for the engineers, and we'll withhold further questions at this time and recognize the gentleman from Pennsylvania.

Mr. CLINGER. Thank you very much, Mr. Chairman.

Gentlemen, I appreciate your presence here today. It's good to see you, John, back with the committee here for this morning's hearing.

John, you indicated that the recommendation is at the present time that any stabilization or any remedial measures on Eisenhower-Snell locks are not required at this time.

Mr. DOYLE. Yes, sir.

Mr. CLINGER. Is there some future point in time at which the Corps might determine that remedial work would be necessary? In other words, do you foresee that that is going to occur any time in the near future or do you think it will not be required for years to come?

Mr. DOYLE. "At this time," to me, means "in the foreseeable future," assuming no change in basic facts. The Seaway Corporation has been taking lock wall measurements for 20 years. That data were reviewed, and show no movement, as I understand it, in the walls. If hypothetically two or three years down the road we should begin to see the situation change, that might be a circumstance indicating that maybe something is changing that would call for us to do more work than has been done so far to revisit the decision. But absent some external indication that the decision we've reached is not a correct one, then the foreseeable future is the time period that I see no need for changes.

Mr. CLINGER. Those checks in measurements will be made on an ongoing basis, so that you will be able to make that determination each year?

Mr. DOYLE. Yes, sir. The Seaway does that routinely, as I understand it, and also has been doing an excellent job operating and maintaining those two locks. To the extent that continues, and there is, as I said, no catastrophic external development, we see no reason at any time soon to call for stabilization of either lock.

Mr. CLINGER. It's my understanding that the conclusion that you've reached here is based upon the Virginia Tech study which was done under contract to the Corps, and their findings are really what led to the recommendation. Have those findings been validated by any other source?

Mr. DOYLE. I am not certain of the answer, sir. Perhaps we can get one of the technical panel that will follow to address the issue.

We have recently published a document that is the proceedings of a workshop that was held in connection with the REMR study. If the committee is interested, I would be more than happy to make a copy of that document available.

Mr. CLINGER. I think that would be very helpful to us.

[The report, "Proceedings of REMR Workshop on Assessment of the Stability of Concrete Structures on Rock," January 1987, final report was received and retained in subcommittee files.]

Mr. CLINGER. It's my understanding that the findings from the Virginia Tech study were reported in April of 1987, which was three months, basically, before our hearing last July. Why didn't we have those findings presented to us at that hearing on July 15th?

Mr. DOYLE. At the time of the hearing it was not recognized that the criteria could be and should be applied to the decision relating to Eisenhower and Snell because we had not reviewed the Gannett-

Fleming design. The decision and the realization that it was appropriate to apply the new criterion came following the site visit.

Mr. CLINGER. Which occurred after the hearing?

Mr. DOYLE. It occurred after the hearing, about a month after the hearing.

Mr. CLINGER. OK. Now the REMR study is going to be concluded in '91?

Mr. DOYLE. In 1989, if I calculate it correctly.

Mr. CLINGER. As the study continues, is there a possibility that the findings that you develop hereafter would or could change the determination with regard to Eisenhower and Snell?

Mr. DOYLE. It's possible, but we think very unlikely. We feel so unlikely that the decision was reached to apply the standards.

Mr. CLINGER. In the event that you are wrong and one or both of the locks collapses, what would be the ramifications of that? In other words, do you agree with the figures that have been floated as to what the ultimate economic cost of that would be?

Mr. DOYLE. I don't know what the ultimate numbers are. There's no question that the Seaway is of tremendous economic importance to the country. The actual amount of potential cost, the amount of time that the Seaway could be shut, and what consequence that might have would depend on the facts of the matter.

Mr. CLINGER. But it could conceivably be closed for upwards of a year or longer to totally rehabilitate it after a collapse?

Mr. DOYLE. I suppose it could, but I'm not certain.

Mr. CLINGER. It's speculative, you think?

Mr. DOYLE. Right.

Mr. CLINGER. Thank you very much.

Mr. OBERSTAR. Mrs. Bentley?

Mrs. BENTLEY. Thank you, Mr. Chairman.

First of all, Mr. Emery, I want to commend you for what you have installed as a maintenance program. I think that is very smart management. It will go a long way toward keeping things going on the Seaway.

On another matter, at the July hearing the subcommittee learned that the Seaway's consultant estimated that $7.5 million in repairs is required for the Eisenhower lock and that the cost for Snell was $6.9 to $9.5 million. Have the Snell lock costs been refined any further?

Mr. EMERY. No, they haven't. They will be going into Snell lock when the season closes the end of this month.

Mrs. BENTLEY. Are you going to dewater it then?

Mr. EMERY. We'll dewater it. They'll make their final tests at that point.

Mrs. BENTLEY. OK. All right, thank you.

Mr. Doyle, what the chairman was questioning in regard to today's engineering reminded of some statements that were made here yesterday concerning highway bridges. First of all, let me say that I've always had the greatest respect for the Army Corps of Engineers and I have worked around them for 30-plus years, so I am fully aware of their capability.

I have some reservations about what's happening today in our whole civil engineering structure, our whole technical structure in this country. The highway administrator yesterday commented

that he was worried about the design of the new bridges today—not of the construction, but of the design. I asked him whether training, education, or the lack of getting the best brains into the civil engineering field today, because of the changes in our society steering young people to high finance and related fields—whether that was having an influence, and he said yes.

I'm wondering whether in the Corps you have become aware of a change in the kind of persons who are coming there as civil engineers and their training and their knowledge, and whether their thinking is different than the old, conservative group who planned these 50-year and 100-year structures—what the chairman was talking about with his comments about the Romans.

What have you found along that line?

Mr. DOYLE. The question is a fundamentally important one. No matter what we want to do, we're not going to be successful unless we have the people with the talent available to make it happen.

More fundamentally, the question that we're dealing with is how do we invest whatever resources we have to address the Nation's problems? That is a question that is a function of the amount of resources we have. That's obvious.

If I remember my history correctly, some of those aqueducts, if not all of the aqueducts, in the projects that the Roman engineers currently have to dig through because they were built so well were built by slave labor—lots of resources and real low costs.

Projects that we built 50 years ago, 40 years ago, were built under different economic conditions than we find ourselves facing now. So the question comes down to, in a field of limited resources, where do we draw the line to try to address as many problems as we possibly can with the proper degree of safety?

Mrs. BENTLEY. Let me interrupt there. Forty or 50 years ago economic resources were scarce. We have more money available today. Even considering inflation, we have more money today. The problem is not money. This is what I'm trying to get at.

Mr. DOYLE. Well, I certainly wish, as I'm sure you do, that we had more. I certainly wish that we didn't have the deficit that we have because clearly those kinds of difficulties operate as constraints on our joint ability to be able to address the very legitimate problems that the Nation has in infrastructure areas.

Mrs. BENTLEY. You still didn't touch on the training of the people.

Mr. DOYLE. I have seen no indication that the people that are coming into the Corps of Engineers are any less qualified than they have been in the past. In fact, I would postulate that exactly the opposite is true—that they are better qualified and every bit as highly committed as people have always been that have worked in the Corps.

Mrs. BENTLEY. All right, let me put it another way: educators today in our higher institutions are urging the young people to go into the field of high finance, to go into banks, rather than going into industry. When you go into industry, you need civil engineers, you need mechanical engineers, you need those kinds of people. The highway administrator said he has found that they are not getting the numbers and the types, the better types of people,

coming through those schools today as they were years ago. That's what I'm getting at.

Mr. DOYLE. I have not seen any indication of that phenomenon in the Corps. In fact, when I've asked those kinds of questions in the year and two days that I've been there, I've seen exactly the opposite. We get some of the finest engineering officers on the military side that the military community and West Point has to offer because the Corps is recognized as being the organization that it is.

Similarly, we are a strong draw for engineering graduates coming out of the schools, again for the same reason.

Mrs. BENTLEY. You may be getting the creme de la creme then for the initial rounds, but it's not just the highway administrator who has told me this. I'm getting this from industry, from heavy industry, and other people who are telling me the same thing.

Mr. DOYLE. I would agree fully—if your statement is that we need more highly-qualified, technically-oriented people in the country, I totally agree with that.

Mrs. BENTLEY. All right. Thank you, sir.

Thank you, Mr. Chairman.

Mr. OBERSTAR. Thank you.

The gentlewoman from New York?

Ms. SLAUGHTER. Thank you, Mr. Chairman.

It's nice to see Mr. Emery here this morning. I welcome him to the committee.

Mr. Doyle, let me apologize to you upfront for missing the first part of your testimony. I had an obligation over on the Floor of the House. But there are a couple questions here that I want to ask you. If you've gone over them, please forgive me, but I really would like to know the answer.

First, on page 5, you discuss the new stability criteria. The assumption I make is that you changed it because you felt that your previous criteria was too conservative. Can I interpret that correctly to mean too cautious?

Mr. DOYLE. You can. I think of it in terms of unnecessary to accomplish the objectives that we believe must be accomplished in terms of making sure that we have a cost-effective, safe engineering solution to the problem.

Ms. SLAUGHTER. On page 6 you talk about the ongoing research program and explain that the study was limited only to sliding and overturning stability of the locks. Is that part of your new criteria? Are those things you consider most important? You say that there are other potential problems involving severe concrete deterioration at the interface, major structural cracks and weak seams. All of those, it would seem to me, are critical concerns and would not properly come under the heading of too conservative if you were to check them.

Mr. DOYLE. First of all, the REMR program is by no means limited to those two factors. The REMR program is a general program that cuts across the full scope of repair and rehabilitation questions.

The comment is in the testimony to point out the fact that the basic request that the Corps received from the Corporation that led to the Buffalo District's report asked us to look at only two questions.

Secondly, again a report that was done following the Buffalo District's report looked at only one of the two questions, in my understanding.

Ms. SLAUGHTER. Right.

Mr. DOYLE. No one has ever tasked us to go beyond that and study to what extent there may be other problems.

Ms. SLAUGHTER. If I understand correctly, you said that your sense of it was that there was no serious problem and that you, as much as is humanly possible, certify the safety and stability of the structures?

Mr. DOYLE. Based on the work that has been done to date and the study that has been done to date, there is no indication that we are aware of, using the criteria that we think are appropriate under these circumstances, to indicate that there is a stability problem of the order of magnitude that would require immediate action to be taken.

Ms. SLAUGHTER. What do you think the likelihood is of the existence of these other problems: the structural cracks, the weak seams, and the deterioration? What action do you expect to take regarding these problems?

Mr. DOYLE. With your permission, Congresswoman, maybe that's a better question for the technicians following this panel.

Ms. SLAUGHTER. I am concerned, Mr. Doyle, that you seem to feel that it's safe and yet it seems to me—and I'm certainly no engineer—that an awful lot of factors have not been studied that could have a critical effect on the safety of the structure.

Mr. DOYLE. I cannot disagree with that statement. There's no question that we have not done a complete and total study of every factor that you or I or others might decide could be relevant for purposes of ultimately asking and answering the stability question. We have seen no persuasive indication in those other areas that there is a problem. We were asked to focus on the two, and those were the two that we did.

Ms. SLAUGHTER. I know we had some severe ice problems up there last year. Maybe Mr. Emery could tell us if he thought that that caused any damage.

Mr. Emery, are you satisfied that they're in good structural condition?

Mr. EMERY. We have those areas that you mentioned other than the structural, where there is a difference of opinion by our consultants and the Corps. Regarding the concrete, we feel we have completed that work. As I mentioned in my testimony earlier, we continue to address the other problems that we have. I think we're well on top of that.

You never know what you're going to find. This is the first year in the history of the Corporation that we will jack the gates to see whether they're still seated properly. I might point out that we are doing that in cooperation with the Corps. We're not adversaries here; we are partners in a lot of the things that we do. We have observed that process I think in Louisville and we're getting ready to do that for the first time.

I don't know what we will find, when you have tons of gates you're going to raise to see what is down there. But I think that our five-year plan that I identified earlier—and this is part of the

five-year plan—is that we are, indeed, looking at every possible thing, and hopefully are repairing it as we find it and we're in good shape.

Ms. SLAUGHTER. I certainly commend you for doing that because, as you and I both know, we've had a series of small, not terribly severe earthquake action up in the north country, that, nevertheless could have affected both the stability and the seating of the lock.

I certainly wish you well with it, gentlemen. Thank you very much.

Mr. EMERY. Thank you for joining us. I didn't have the opportunity to say good morning to you.

She's my neighbor back in New York to the north and we served together, Mr. Chairman, in the State legislature.

Ms. SLAUGHTER. We're fellow gardeners, aren't we?

Mr. EMERY. That's right.

Mr. OBERSTAR. Very good.

A vote is in progress, but the Chair would like to proceed with a few further questions.

Mr. Emery, the result of the letter from the Assistant Secretary of Army for Civil Works to the Secretary of Transportation had the result of the Seaway Authority, in fact, recommending cancellation of the funding requested for the major rehabilitation.

Now the question I have is, Did you have an opportunity—you, Seaway Authority and your engineers—to consult with the Corps on its findings and on the recommendation, and did your engineering staff rebut or offer any rebuttal to the findings of the Corps in view of the information presented at this subcommittee hearing earlier in the year?

Mr. EMERY. Let me answer the first part first, which I don't think was a question; I think it was a statement. My policy has been since I have been in this position to share with those whom we think have an interest, whether it be the Appropriations Committee, whether it be OMB, whether it's the Public Works Committee in the House and the Senate, information that we develop that is reported to us. When the Corps letter came in to the Secretary, to Secretary Dole, we did distribute that to those people whom we felt had a need to know and a right to know on that basis.

I should point out we never did have in our '88 budget request a formal request to fund this. We do have in our '89 budget that request. That request is still valid at OMB. You can interpret what they are going to do with it on the basis of the letter they have. I can't answer that for you.

Mr. OBERSTAR. My understanding is that OMB has not yet chopped that off the budget.

Mr. EMERY. They have not yet said, "Shouldn't that or can that go forward?"

On the basis of the second part of your question, yes, we did meet in our office, I believe, with Gannett Fleming representatives, our engineers, and at the end of the meeting there was still disagreement. I think the technical people probably can tell you what those disagreements were, but we still have that basic—our consultants and our engineering staff, disagreement with the Corps findings.

Mr. OBERSTAR. So your engineers do not concur in the report of the Corps as submitted to the Secretary of Transportation?

Mr. EMERY. I believe I am correct in saying they do not.

Mr. OBERSTAR. That's fine.

However, a letter, nonetheless, went forward from you to the Secretary of Transportation. We have that and I would like to enter it in the committee hearing record at this point.

[Letter referred to follows:]

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

14 OCT 1987

Honorable James L. Oberstar
Chairman
Subcommittee on Investigations
and Oversight
Committee on Public Works
and Transportation
House of Representatives
Washington, D. C. 20515-6259

Dear Mr. Chairman:

Enclosed for your information is a copy of my letter to the Secretary of Transportation concerning the Army Corps of Engineers evaluation of the priority for remedial measures to stabilize the walls of the Eisenhower and Snell Locks.

Sincerely,

Steven Dr Co, Acting

for John S. Doyle, Jr.
Acting Assistant Secretary of the Army
(Civil Works)

Enclosure

DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, DC 20310-0103

30 SEP 1987

Honorable Elizabeth H. Dole
Secretary of Transportation
Washington, D. C. 20590

Dear Madam Secretary:

The purpose of this letter is to inform you of the results of the Army Corps of Engineers technical evaluation of the proposed rehabilitation of Eisenhower and Snell Locks by the Saint Lawrence Seaway Development Corporation and its contractor, Gannett Fleming Geotechnical Engineers (GFGE). This evaluation was developed as a result of discussions between our two Departments following joint testimony before the Subcommittee on Investigations and Oversight, Committee on Public Works and Transportation, House of Representatives, on July 15, 1987, on the cost of rehabilitation of these locks.

I have been informed by the Deputy Director for Engineering and Construction of the Headquarters, U. S. Army Corps of Engineers, that it is the position of the experts in the Corps that both Eisenhower and Snell Locks are stable against overturning and sliding and, therefore, no remedial measures for stabilizing the lock walls are needed at this time. This conclusion is based on a review of GFGE reports; a site visit on August 21, 1987; and the newly available research results by the Corps on the stability of existing concrete navigation structures. A more detailed discussion is provided in the enclosure.

Please note that the position of the Corps is not in agreement with the recommendations contained in the GFGE reports. The disagreements arise from differences of opinion between GFGE and the Corps over how the stability of the concrete navigation structures should be evaluated. This is not a new issue and, because significant rehabilitation costs are at stake for these and other structures, the opinion of the Corps is based, in part, on the preliminary results of this research. It also should

be noted that the evaluation was limited only to the sliding and overturning stability of these locks. The concrete conditions and potential structural problems, if any, were not evaluated.

Sincerely,

(Signed)

John S. Doyle, Jr.
Acting Assistant Secretary of the Army
(Civil Works)

Enclosure

DISCUSSION ON POSITION OF THE ARMY CORPS OF ENGINEERS CONCERNING EISENHOWER AND SNELL LOCKS

Based on the review of Gannett Fleming Geotechnical Engineers (GFGE) reports, a recent site visit, and the newly available research results on the stability of existing concrete navigation structures, it is the position of the Corps of Engineers that both Eisenhower and Snell Locks are structurally stable against overturning and sliding and, therefore, no remedial measures for stabilizing the lock walls are needed at this time. More detailed discussions follow:

> The need for remedial measures for structural stability for these locks, proposed in the 1985 Reconnaissance Report prepared by the Buffalo District of the Corps of Engineers, was based on the then-available stability criteria which are now believed to be excessively conservative.

> A Corps-sponsored research investigation, as a part of the comprehensive Repair, Evaluation, Maintenance, and Rehabilitation (REMR) research program, was initiated in 1985 for the purpose of evaluating the accuracy and reliability of the conventional stability analysis methods for the existing concrete navigation structures on rock foundations. Two very significant findings were reported in April 1987. The research results indicated that:

- The conventional stability analysis methods may be excessively conservative because the important vertical shear loads on the wall were not included in the analysis. Examination of the research results showed that the shear loads result from the tendency of the backfill to settle slightly under its own weight as it is placed in lifts and does not require movement of the wall. These shear loads provide a stabilizing moment on the wall and increase the normal contact forces between the base of the wall and the foundation rock. The factors governing the magnitudes of these shear loads are being investigated further.

- The lateral earth pressures can be greatly reduced with very small wall movements. The use of at-rest earth pressures, as currently being used for stability analyses, may be too conservative for certain types of backfill materials. Since the wall must translate and/or rotate prior to failure, the lateral earth pressures used for stability analyses may be reduced from the at-rest condition to the active condition.

> As a result of this REMR research, the Corps stability criteria for existing concrete navigation structures on rock foundations are being revised to permit the use of the shear loads on the wall and the use of active earth pressure for dense and stiff backfill materials. The stability of these locks will be satisfactory if evaluated against the newly developed stability criteria.

> These locks have been operated and dewatered many times during their service life without stability problems. The Saint Lawrence Seaway Development Corporation has taken parapet-to-parapet measurements of the lock chamber widths at various times for the last 20 years at both Eisenhower and Snell Locks. These measurements indicated that the chamber widths fluctuate normally in response to the water level in the chamber and showed no indication of any stability problems.

> Although GFGE did a very professional job in collecting and evaluating the in situ test data and in preparing recommendations for remedial design for these locks, the Corps of Engineers does not agree with the methodology used by GFGE for sliding stability analysis and the use of measured at-rest earth pressure for both sliding and overturning analyses. More detailed discussions follow:

- GFGE used the shear-friction method for evaluation of sliding stability and for its remedial design. Current practice by the Corps uses the limit-equilibrium method. Although both shear-friction and limit-equilibrium methods have their limitations and imperfections, it is the opinion of the Corps of Engineers that the limit-equilibrium method is a better method, which uses the strength of the backfill material that represents the in situ conditions. The shear-friction method is no longer used by the Corps.

- GFGE used measured at-rest earth pressures for both sliding and overturning stability analyses. It is the Corps opinion that these measured earth pressures appear reasonable as a basis for structural designs. However, these measured earth pressures may not be appropriate for stability analyses. Although the use of at-rest earth pressures for overturning stability analyses is specified in the Corps criteria documents, we now believe that, based on the recent research results, pressure approaching active should be used instead. This is especially true for dense backfill materials, such as those found at Eisenhower and Snell Locks.

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DEPARTMENT OF THE ARMY ETL 1110-2-xxxx
U. S. Army Corps of Engineers
CEEC-ED Washington, D. C. 20314-1000
CEEC-EG

Engineer Technical
Letter No. 1110-2-xxxx

Engineering and Design
STABILITY CRITERIA FOR EXISTING CONCRETE
NAVIGATION STRUCTURES ON ROCK FOUNDATIONS

1. Purpose. The purpose of this letter is to provide interim criteria and procedures for analyzing and for improving the stability of existing concrete navigation structures on rock foundations. Concrete navigation structures include lock walls, lock chambers, and approach walls.

2. Applicability. This letter is applicable to all field operating activities having responsibilities for the design and construction of civil works projects.

3. References. See Inclosure 3.

4. Background. Past practice has been to use the same stability criteria for designing new structures and for reviewing existing structures. Most of the existing structures, although not meeting the referenced stability criteria (ref. 5, 6, 7 & 8), have performed satisfactorily for many years. It may not be necessary to improve the structure's stability to satisfy the referenced criteria when the remaining life of the structure is relatively short or when there are no indications of any stability problem. Relaxation to the referenced criteria have been granted on a case by case basis. A research investigation, as a part of the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Program (ref. 9), was undertaken to study the stability of the existing concrete structures. The preliminary results of the REMR research and the experience from recent rehabilitation projects are included in this ETL. Revisions will be made as the additional results from REMR research and other sources become available.

5. Procedures. The following procedures shall be used in the evaluation of current stability conditions and in the determination of necessary corrective measures. They should be considered as guides and are not intended to replace engineering judgement by the engineers responsible for the project. The stability condition should be reviewed when there are significant changes in the loading conditions, severe damage due to accident,

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aging or deterioration, discovery of structural deficiencies, revision of stability criteria to become more conservative, or when required by ER 1110-2-100 (Ref. 2). The phases listed below shall be followed in sequence until the prescribed conditions are satisfied. The procedures are illustrated with a flow chart in Inclosure 1.

a. PHASE I, Preliminary Analyses and Evaluation. Preliminary analyses should be performed based upon available data and actual conditions of the structure. Before performing the analysis, it is important to collect and review all the available data and information for the structure including geologic and foundation data, design plans, as-built plans, periodic inspection reports, damage reports, repair and maintenance records, plans of previous modifications to the structure, measurements of movement, instrumentation data, and other pertinent information. It may be necessary for the engineer to inspect and examine the existing structure to assess its condition. Friction between the backfill and wall or on a plane within the backfill may be considered in the stability analyses of existing structures. Recent REMR research indicated that neglecting wall friction is unnecessarily conservative. The shear force on the assumed shear plane may be calculated as follows

$$S = K \phi N$$

where S = shear force on the assumed shear plane.
K = effective factor, not more than 0.5.
ϕ = internal friction angle of the backfill or interface friction angle between backfill and the wall.
N = Normal force on the assumed shear plane.

If the results of the analyses indicate that the structure satisfies the referenced stability criteria, no further investigation is needed. Otherwise, list all the possible remedial schemes and prepare the preliminary cost estimate for each scheme. ER 1130-2-417 (ref. 4) should be followed if applicable.

b. PHASE II, Study, Investigation, and Comprehensive Analyses. When the preliminary analyses indicate that the structure does not meet the referenced criteria, a meeting should be arranged to decide on plans for the proposed comprehensive analyses, and to define the extent of the sampling and testing program, the remedial schemes to be studied, the extent of the parametric study, and the proposed schedule. This meeting should include representatives from the district, division, CEEC-E, and CECW-O. The meeting will facilitate the design effort and should

obviate the need for major revisions or additional studies when the results are submitted for review and approval. The parametric study should be performed to determine the effect of each parameter on the structural stability. The parameters to be studied should include, but not be limited to, unit weight of concrete, ground water levels, uplift pressures, and shear strength parameters of the backfill material, rock or soil foundation, and structure-foundation interface. The maximum variation of each parameter should be considered in determining its effect. An exploration, sampling, testing, and instrumentation program should be developed, if needed, to determine the magnitude and the reasonable range of variation for the parameters which have significant effects on the stability of the structure as determined by the parametric study. The division laboratory should be used to the maximum extent practicable to perform the testing in accordance with ER 1110-1-8100 (ref. 1). Comprehensive stability analyses should be performed using the material properties obtained from the sampling and testing program and procedures from referenced guidances plus the use of shear friction as discussed in paragraph 5.a. Lateral earth pressure may be reduced to the active state except when very loose or expansive material was used for the backfill. Preliminary results from REMR research indicate that the lateral earth pressure can be greatly reduced from the at-rest pressure with very small wall movement ratio (ref. 9). Since the wall must translate and/or rotate prior to failure, an active condition is justified in the analyses for structures with dense and stiff backfill. Smaller reduction should be used for other types of backfill (p.380, ref. 10). The amount of reduction of lateral earth pressure should be determined after careful evaluation of data from field investigations and material testing. Three dimensional modeling should be performed to achieve a more accurate prediction of the structural behavior when required (ref. 12). No remedial measures are required if the referenced criteria are satisfied.

c. PHASE III, Deviation from Referenced Criteria. If the structure still cannot meet the referenced criteria, deviation may be considered. Since the purpose of incorporating a factor of safety in structural design is to provide a reserved capacity with repect to failure, a lower factor of safety may be justified in the analysis of existing structures if a higher degree of confidence in the values of the critical parameters can be achieved from the field investigation. Table 1 lists the minimum stability criteria for the analysis of existing structures. If analysis indicates safety factors are above the values listed in Table 1, the stability of the structure may be acceptable without remedial measures. The request for deviation from the referenced criteria shall be submitted to CEEC-E for

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approval with the following documentation:

(1) Comprehensive stability analyses and cost estimates for all schemes of remedial measures.
(2) Past performace of the structure, inculding instrumentation data and description of the structure condition such as cracking, spalling, displacements, etc.
(3) The anticipated remaining life of the structure.
(4) A description of consequences in case of failure.

TABLE 1
MINIMUM STABILITY CRITERIA FOR
EXISTING NAVIGATION STRUCTURES

CASES	NORMAL COND.	MAINT. COND.	SEISMIC COND.
% COMP. AREA/ BASE AREA	75%	50%	RESULTANT WITHIN BASE
F.S.--SLIDING	1.60	1.25	1.10

NOTE: Maximum base pressure shall not exceed the allowable unit bearing capacity of the foundation material in all cases.

6. Stability Requirements For Remedial Measure. The reduction of lateral pressure and introduction of shear friction as listed in paragraph 5.a and 5.b and the relaxation of design criteria in Table 1 shall not be used in the design of remedial measures such as prestressed and non-prestressed anchors. The remedial measure shall be designed to meet the referenced stability criteria. In unusual cases where this is not practical, the allowed minimum stability criteria shall be determined at a meeting with the district, division, CEEC-E, and CECW-O. Construction plans, specifications, and cost estimate for the proposed remedial measures should be developed in accordance with ER 1110-2-1200 (ref. 3).

7. Prestressed Anchors. Prestressed anchors may be used to stabilize the existing walls, foundation slabs, and concrete monoliths. They are effective in improving the safety factors against overturning, sliding, and uplift. The number, orientation, and capacity of anchors used should be based on engineering considerations and stability requirements. The existing concrete and structure should be checked for its

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adequacy to withstand the sustained load at the anchorage points. Anchors installed in aggressive environments should be provided with double corrosion protection. Design, installation, and testing of anchors and anchorages should be in accordance with reference 11. Allowable bond stress used to determine the length of embedment between grout and rock should not be more than 50 percent of the ultimate bond stress determined by tests. The values of bond strength in paragraph 4.3.2.6 of reference 11 may be used in lieu of tests during the design, but the design value should be verified by tests before or during construction. In addition to the first three anchors, a minimum of five percent of the anchors, but not less than two anchors, selected by the engineer, shall be performance tested.

8. Non-prestressed Anchors. Non-prestressed anchors shall not be used if other options are feasible. The effectiveness of this system is questionable and undependable due to the movement required to activate the anchor force. Therefore, the system should not be considered as effective in improving the safety factor for the structure's stability. They may be used as the last resort to prevent any possibility of catastrophic failure. The location, design, and installation of the anchors may follow the guidance provided in Inclosure 2. Bond strength used in calculating embedment length shall be verified by pull out tests in the field or laboratory.

FOR THE COMMANDER:

WILLIAM N. McCORMICK, JR.
Chief, Engineering Division
Directorate of Engineering and
Construction

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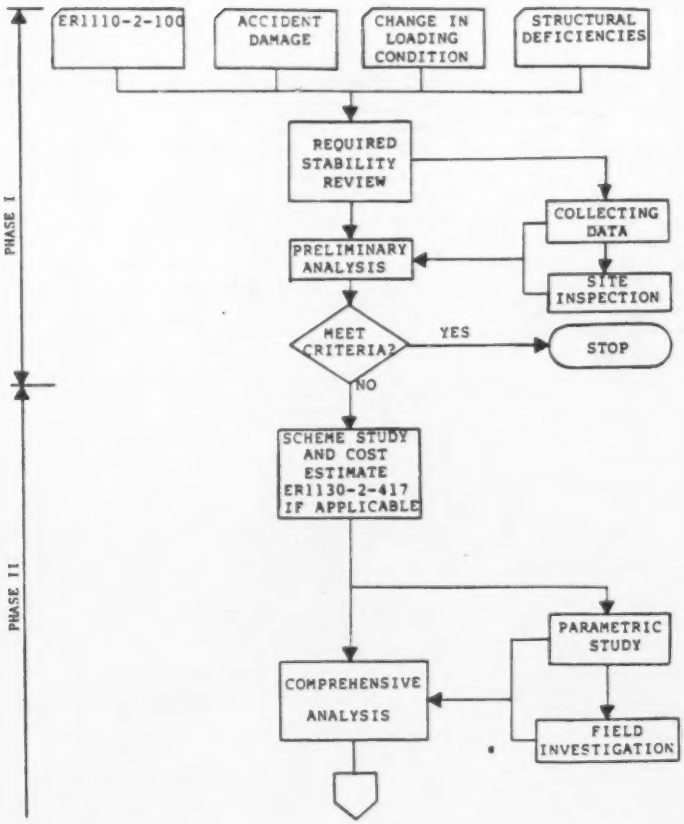
Sequence of Stability Evaluation for
Existing Structures



Inclosure 1

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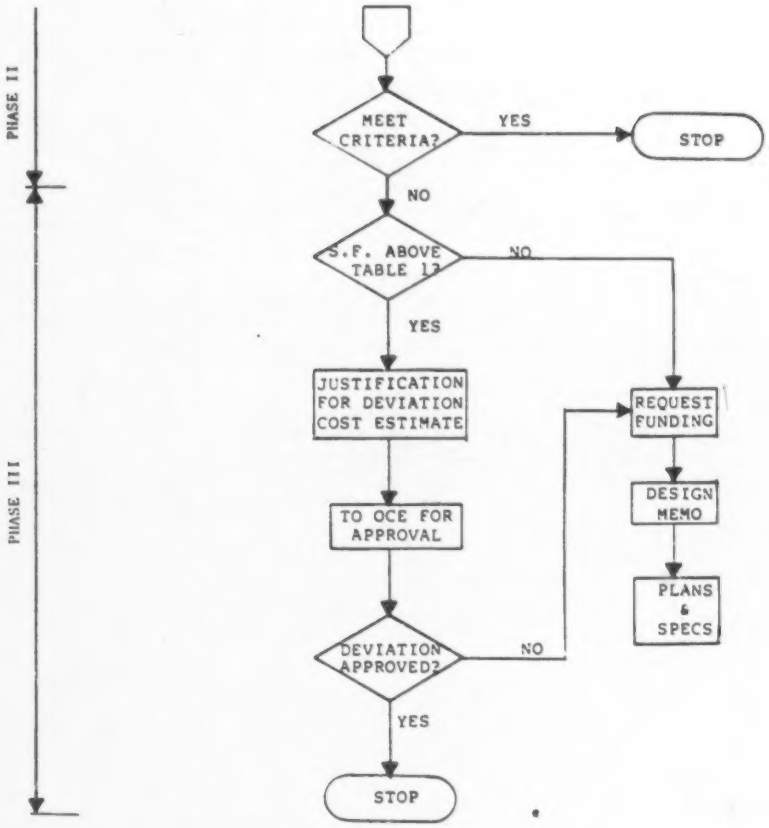
PHASE II
PHASE III
MEET CRITERIA?
YES
STOP
NO
S.F. ABOVE TABLE 1?
NO
YES
JUSTIFICATION FOR DEVIATION COST ESTIMATE
TO OCE FOR APPROVAL
DEVIATION APPROVED?
NO
YES
STOP
REQUEST FUNDING
DESIGN MEMO
PLANS & SPECS

Guidance for the Design, Installation,
and Testing of Non-prestressed Anchors

1. General. Non-prestressed anchors are installed similar to prestressed anchors except no post-tensioning is applied and anchors are grouted full length. They do not physically impart an immediate active force to the structure. The anchor force will be activated only when the structure moves. Therefore, it is desirable that these anchors be installed with the minimum lateral loads on the structure, thereby activating the anchor force partially under the normal load and minimizing the movement of the structure beyond its normal position when the anchor force is fully activated.

Non-prestressed anchors should be considered as a temporary measure. If the remaining or extended life of the structure is anticipated to exceed ten years, other options or total replacement should be considered.

2. Method of Analysis. The method of analysis and loading conditions for determining overturning and sliding stability should be in accordance with applicable references in Inclosure 3 and the guidance provided herewith. Due to uncertainties in structural behavior and lack of research in this area, shear friction under the footing or dowel action of the anchors should not be included in calculating the sliding resistance.

3. Type and Material. Most anchors used in this system are reinforcing steel bars. Other materials and shapes are also allowed if they are more economical. Mechanical connectors should be avoided whenever possible since they will complicate installation and increase overall costs. The bars should be anchored in the foundation and concrete structure using a portland cement grout or epoxy resin. The bond force of the grout or resin should be sufficient to support the ultimate force of the bar used.

4. Design Considerations. Due to the lack of a positive downward force from non-prestressed anchors, cracks under the footing will likely be created when activating the anchor force. These cracks will change the seepage pattern and redistribute the uplift pressure under the foundation. To be conservative, it is assumed that the cracks will penetrate to the point where the compression zone ends assuming there is no anchor force. The following guidelines are provided in designing non-prestressed anchor system:

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a. Allowable Design Strength

High strength bar	ASTM A722, Type II	$P_{all} = 0.60\ P_{ult}$
Reinforcing bars	ASTM A615, Grade 60	$P_{all} = 0.80 f_y * A_b$

Where

P_{all} = Allowable anchor force, lb
P_{ult} = Ultimate tensile force guaranteed by manufacturer, lb ($f_u * A_b$)
f_y = Yield strength of bar, psi
A_b = Area of bar, in^2
f_b = Ultimate strength of bar, psi

b. Embedment Lengths within structure. Usually, the bond between grout and concrete is stronger than the bond between bar and grout. In case the bond strength between grout and concrete is suspect due to the condition of the existing structure, a field test should be performed to determined the actual bond strength. The embedment length of anchor bar within the concrete structure should be computed with the following equation:

$$L = \frac{P_{all}}{\pi d_b f_{ba}} \qquad (2\text{-}1)$$

Where

L = Embedment length, in
d_b = Diameter of the bar, in.
f_{ba} = Allowable bond stress, normally equal to $0.25 f_{bu}$, psi.
f_{bu} = Ultimate bond stress between bar and grout or between concrete and grout, whichever is less, psi.

The value of f_{bu} should be determined from tests. In lieu of test, f_{bu} may be conservatively assumed as $6\sqrt{f_c'}$ where f_c' is the strength of concrete or grout.

c. Embedment lengths within foundation. The largest value of L in (1), (2), and (3) below should be used as the embedment length within the rock foundation.

(1) Bond Between Bar and Grout

$$L = \frac{P_{all}}{\pi d_b f_{ba}} \qquad (2\text{-}2)$$

(2) Bond between grout and rock

$$L = \frac{P_{all}}{\pi d_h f_{ca}} \qquad (2\text{-}3)$$

Where

d_h = Diameter of drilled hole, in.
f_{ca} = Allowable bond stress equal to $0.25f_{cu}$, psi.
f_{cu} = Ultimate bond strength between grout and rock, or c, whichever is less, psi.
c = Cross bed shear value in rock in the direction of pullout, psi.

The value of f_{cu} should be determined from field tests. In lieu of test, table in Paragraph 4.3.2.6 in reference 11 may be used during the design. However, this value shall be verified in the field before installation. In case of multi-layer rock foundation, the total bond should be the summation of the bond of each individual layer. In weak rock foundation, underream bell may be considered to increase the pullout resistance in which case, d_h in Equation 2-3 shall be replaced by $0.66d_R$ where d_R is the diameter of the underream bell.

(3) Rock mass shear failure. Normally, rock mass failure will not govern the design. In case of weak or cracked rock foundation or shallow anchors (less than 10') where this type of failure is deemed possible, a rational analysis shall be performed to ensure the adequate embedment length. Parameters used in the analysis should be based upon field and laboratory tests. In lieu of a more detailed analysis, a failure surface in the shape of a cone with 30 degree tip angle may be assumed for each anchor. Consider only the weight of the rock within the cone in computing the resistance capacity of the anchorage. In case of closely spaced anchors, resistance capacity should be multiplied by a factor of (2s/L), but not more than 1.0, where s is the spacing of anchors and L is the embedment length.

5. Construction Guidance. The design engineer should specify the diameter, depth and alignment tolerance for the anchor hole. Drilling, testing for watertightness, and insertion and grouting of anchor should follow the requirements in reference 11. Normally, anchor holes should not be closer than five feet center to center or within two feet of an expansion joint or face of the structure. In case a weak layer of rock material is encountered in the foundation, consideration should be given to staggering the anchor depths to avoid laminar failure. The contract documents should include an installation and monitoring procedures to insert the anchor to the proper depth and to keep the bar centered in the hole. After the anchor installation,

grouting can be accomplished by either a gravity or pressure method. Resin anchors, if used, should meet the requirements in paragraph 4.4 of reference 11. The choice of grouting methods should be based on an evaluation of the site foundation data, anchor orientation and structural considerations. In non-prestressed anchor system, free stressing length is not required and grouting in rock and structure may be applied at the same time.

6. Testing Requirement and Procedures. Field tests shall be performed before and during the installation to verify the adequacy of the anchor system and installation procedures. Tests before installation shall be used to check the performance of selected drilling method, conformability of hole size and drift tolerances, adequacy of anchor installation and grouting method, and accuracy of assumed bond strengths between grout and rock, grout and concrete, and grout and bar. Tests during the installation should be adequate to ensure that anchors are installed to the requirements of the plans and specifications and can develop the designed force. The number of tests required depends on the site specific information including drilling conditions, type and/or size of bars, and complexity of foundation formation and material.

7. Protection Criteria. Since the entire length of the bar is grouted in cement or resin and the system is considered temporary, no additional protection is required. However, if the bar is embedded in a highly corrosive environment, additional protection such as epoxy coating or plastic sheathing should be provided.

DRAFT

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5. EM 1110-2-2602, "Planning and Design of Navigation Lock Wall and Appurtenances"

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Mr. OBERSTAR. You accept the judgment of the Corps of Engineers. Why was that letter sent?

Mr. EMERY. I don't know if we sent a letter. That's my statement. I issued a statement to the fact that——

Mr. OBERSTAR. That's correct; I think it was a news release.

Mr. EMERY. Yes.

Mr. OBERSTAR. It was in the news release, the statement that was made.

Mr. EMERY. Well, we set out—as I mentioned in my opening remarks, there were three things that we felt were necessary to address for the credibility and integrity of the system. I have spoken about that now for about three years, I guess. One was the concrete deterioration; two was the stability; and three was the contingency plan. That's been the topic of speeches of mine internationally—what we're doing to address them.

All of a sudden, we find ourselves that the experts, as has been pointed out here, the Government experts in engineering have said, "You no longer have a problem." I felt it incumbent upon me to now notify those people that with that decision made by people who are the experts in this field that we no longer have a problem.

Our engineers and our consultants disagree with that, but I accept the view very similar to the auditors and the Comptroller General who come up every year. I may disagree with what their findings are, but, nevertheless, if they recommend that we have a different procedure, we institute that. They are, again, the experts.

That's the position they took, and we certainly didn't want the world to be out there waiting for a stability repair when there wasn't going to be one, in our opinion. Therefore, we let that—put that word out.

Mr. OBERSTAR. Yet, the engineering experts have a judgment difference with the Corps on this issue, and your statement says if these experts, referring to the Corps of Engineers—as you put it, "The Corps of Engineers is our Nation's foremost engineering and lock building organization. If these experts do not believe we any longer have a lock stability problem, it is senseless for our Corporation to pursue this project any further. We are relieved that no problem exists and consider the three-phrase preventative maintenance program launched in 1986 to now be complete." I'm leaving out a few words in there.

I think that statement, carefully couched and carefully worded as it is, reflects a reality of the process but does not come to grips with the substance of the issue. That is whether that engineering judgment is, in fact, right.

Mr. EMERY. I think your statement is correct, although I am not in a position to be not being an engineer, not being well versed, I can't make that determination, other than I certainly have the fullest confidence in the engineering firm that we hired, and I think the Corps of Engineers recognized that we have a foremost engineering firm doing that work.

I am in the same quandry you are—that I have two experts—one on the right and one on the left—telling me contradictory things. I just am not qualified to make that decision, to cut through that. I would hope that the purpose for your hearing is to try to find—if there is, indeed, some basis for disagreement?

Mr. DOYLE. Mr. Chairman, may I comment on that real quickly?

Mr. OBERSTAR. We'll get to that matter in the next panel. We're going to look at the engineering aspects of this immediately following this vote?

Mr. Doyle?

Mr. DOYLE. First of all, I want to concur fully in what Jim has said with respect to the qualifications of Gannett Fleming. In my understanding, there is no disagreement between that firm and the Corps with respect to us looking at their report and any of the technical work that they have done, and from their looking at our REMR efforts and technical work that we have done. I don't think there is a disagreement of that kind. The disagreement exists insofar as trying to decide which criteria should be applied in this particular situation, but I don't think either organization is challenging the expertise of the other and the work that's been done by the other.

Mr. OBERSTAR. I have one final question for Mr. Doyle, but we have about four minutes remaining on this vote. I will have to recess for about 15 minutes to vote and return.

[Recess taken.]

Mr. OBERSTAR. The subcommittee will be in order.

Just a couple of other questions. If locks are now in place, in operation, might the REMR study recommendations and conclusions be applied?

Mr. DOYLE. Mr. Chairman, we are applying these new criteria that have been applied to Eisenhower and Snell with respect to all of our repair and rehabilitation questions for any project that will have a new study conducted from this point forward, from the point that the policy was made. So any new effort that we have underway with respect to evaluating the need for major rehabilitation of lock and dam structures will have the new criteria applied.

Mr. OBERSTAR. That would include anything that was in H.R. 6 in the way of rehab?

Mr. DOYLE. I'm trying to remember if there is anything in H.R. 6 that's rehabilitation.

Mr. OBERSTAR. I didn't take the time to go and look through that, but I——

Mr. DOYLE. I don't recall anything, but it's only with respect to new study efforts that we initiate from the point of the policy change forward.

Mr. OBERSTAR. It still nags at me from a policy standpoint, if this document is labeled "Draft Preliminary Report," and yet its conclusions are applied to the Eisenhower and Snell locks, is that not a draft preliminary and premature decision?

Mr. DOYLE. We think that it's not a premature decision.

Mr. OBERSTAR. Let us hope that if this decision stands, is not challenged and reversed, if that work is not done, that there is no overturning or slippage or major movement of monoliths in either of those two locks because it occurs to me that this draft report would be little comfort to the port authorities, the shippers, the Seaway operators when the Seaway is closed if something disastrous does occur.

Mr. DOYLE. Mr. Chairman, I fully agree with that, and would even go so far as to say if we had a final report or a tablet with

something carved in stone that said it was safe but nonetheless had a problem, that would provide little comfort. We'd still have a very important problem with which to deal.

Mr. OBERSTAR. A matter that is somewhat—in fact, beyond the scope of this hearing, but I wanted to take the opportunity to raise this matter. It has come to the subcommittee's attention that the Department of the Army has proposed a rule that would change the Corps' procurement policy on the 50 percent bid preference for domestic products.

I understand that the Corps' procurement program has been functioning very smoothly. I've had occasion to look at a number of Corps projects in the area of Buy America, but I'm just wondering if there aren't some changes in that policy that might be of concern not just to this subcommittee, but to the full committee, given your long understanding of this committee's very firm commitment to Buy America and use of domestic materials in projects authorized by our committee.

Mr. DOYLE. Yes, sir. I believe that what you're referring to is an effort currently underway to revise a Department of Defense Federal acquisition regulation relating to an interim balance of payment corrective measure that has been in place for a number of years. If the current proposal goes forward in its proposed form, the civil works program would be excepted from the otherwise applicable DOD requirement relating to what percentage of directly-purchased goods must be purchased domestically.

We are currently in the process of evaluating to what extent we need to change our procedures. This came about as the result of a problem that was identified a couple of years ago involving two different Corps of Engineer districts applying the then-applicable policy differently—one district applying a 50 percent rule, the other district applying a 6 percent rule. That raised the issue.

It's a consistency problem. Generally speaking, I agree fully that the acquisition process of the Corps' civil works program is working well. We have a consistency problem, and the two options that we are considering are essentially designed to make everyone apply the 50 percent rule, or make no one apply the 50 percent rule. We have opted for the latter, the exception approach. I think it has been partly misunderstood and that misunderstanding has led to some misinterpretation and perhaps a higher level of concern than might be the case if it were understood.

First of all, the new practice would principally apply to the civil works program steel purchases, which are roughly 1 percent, as I understand the numbers, of steel purchases. Then, within the civil works program, only about 1 percent of that total would be affected, because the new policy applies only to direct purchases which are purchases by the Corps of Engineers directly dealing with the supplier. As you so well know, most of the work that we do in our program involves the Corps contracting with a contractor who then deals with the supplier and, therefore, is not covered by the new regulation, whichever way it goes.

So we're in the process of looking at the question, receiving comments. The comment period has closed. We're in the process of evaluating those comments and have yet to make a final decision about that.

Mr. OBERSTAR. What is the time frame within which that final decision may be made?

Mr. DOYLE. There is no milestone that has been set that I'm aware of. We have all the comments. The comment period was extended once for a 60-day period, if I recall, and we're now evaluating that body of comment. When we reach our conclusion, we'll let you know, sir.

Mr. OBERSTAR. We'll direct to you in writing questions that can provide us with more complete information. I appreciate this preliminary response on your part.

Mr. OBERSTAR. I just want to remind those who are involved in the decisionmaking process that as recently as two weeks ago the government of Japan told our Secretary of Commerce "no" when he asked for American construction firms to be permitted to bid on construction work of the Japanese government—not "we'll consider it;" not "we'll think it over;" not "there's a rulemaking procedure;" not "there's a long time frame but come in and give us evidence;" just flat "no."

I would also remind that from the end of World War II until 1969 the Japanese did not import as much as a million tons of steel totally in that period of time until they had rebuilt a steel industry that rivaled—that could and, in fact, did rival—that of the United States. When they were ready to enter the world marketplace, they unloaded on the United States, and in the 15 or so years following their entry into the world market, by various devices they kept American steel out of Japan until just recently when they purchased 100,000 tons from United States Steel.

I don't like the idea of American locks and dams and bridges, highway structures, being built with foreign steel when our steelworkers and our iron ore miners in northern Minnesota are out of work and could be providing that steel. I just want you to keep that in the back of your mind.

Mr. DOYLE. Sir, I'll keep it in the front of my mind. [Laughter.]

Mr. OBERSTAR. Thank you.

Mr. Stangeland?

Mr. STANGELAND. Thank you, Mr. Chairman. I have a statement here I'd like to have made a part of the record.

I just want to commend you for holding the hearing. I think it's extremely timely and I look forward to working with you.

Then I couldn't resist the opportunity to be here for at least a short while to welcome the very distinguished Acting Assistant Secretary for Civil Works, John Doyle; to say that he is still greatly missed for the work that he did as a staffer on this committee. I have every confidence that as the Acting Assistant Secretary—and I would have hoped that he could have been made the Assistant Secretary—that he is doing an excellent job with the Corps. He certainly is one man that we have no problem working with and will be very responsive, I think, to what the committee and the Congress requests because of his background and experience here.

Welcome back.

Mr. DOYLE. Thank you, sir. It's great to be here.

Mr. OBERSTAR. Without objection, the gentleman's statement will be included in the record at the outset of the hearing.

The Chair will note that the Acting Assistant Secretary's praises have already been sung. However, we will withhold judgment on his cooperativeness with the committee until after we've resolved the Seaway locks question. [Laughter.]

The gentleman from New York?

Mr. NOWAK. I thank the chairman. I also want to congratulate him for looking at this problem and holding these hearings. I'm sorry I was not able to get here for the direct testimony. However, I have read some of the work. I also apologize if I ask a couple of questions that perhaps the chairman has already gone over.

I want, too, to welcome John Doyle and Jim Emery, two very good, hard-working men in their respective positions.

What I guess we're trying to do on this committee is make sure that we do everything possible to have this system in place at least during the days while we're still in Congress. To get to some of the reasons for the change in the Corps' posture on repairing these locks, I'm just wondering—I understand there were new criteria that changed the Corps' opinion as to whether this work should go ahead, and that new criteria were developed in a document called "Methods of Evaluating the Stability and Safety of Gravity, Earth-Retaining Structures." The copy that I have before me is marked with a draft imprint on it. I would assume that these numbers, Mr. Doyle, were used for your "second look" at the work required from the first Corps report; is that correct?

Mr. DOYLE. Yes, sir.

Mr. NOWAK. The draft, therefore, had it not been in existence when the review was made—and I understand that review was made using all the material that had been developed before that and a one-day trip to look at the locks in place at Massena sometime after our hearing here in July; is that correct?

Mr. DOYLE. That's correct. While we had the data prior to the hearing, it was not until after the site visit, which occurred approximately a month after your July hearing, that a decision was reached based on the information that was developed at the site visit and the analysis that took place subsequent to the hearing to apply the new criteria to Eisenhower and Snell.

Mr. NOWAK. But had the draft not been in existence or under consideration at that time, had not progressed, I assume, then, the decision would have been made based upon the previous criteria and, therefore, it would have been feasible to go ahead with the work as recommended; is that correct?

Mr. DOYLE. Yes, sir. It's difficult to say with total certainty that the decision would not have been made, but I think it's a fair assumption to say that the availability of the results contained in that work product coming out of the REMR program had a substantial and maybe persuasive effect on the decision that was made.

Mr. NOWAK. When would you expect this draft to be reviewed and finalized for the Corps?

Mr. DOYLE. I don't have an answer to that right here, sir. I'm not certain what the exact date would be, but I'll provide that for the record.

[The following was received from Mr. Doyle:]

The Engineer Technical Letter has been approved for publication. It will be printed in the second quarter of fiscal year 1988.

Mr. OBERSTAR. If the gentleman would yield—earlier, Mr. Doyle, you said you anticipated sometime in Fiscal Year 1990.

Mr. DOYLE. That is the conclusion of the REMR program. What I was addressing in my comment to Mr. Nowak was what I understood him to be asking, about which was that particular report.

Mr. NOWAK. The final document, then, is anticipated in 1990; is that——

Mr. DOYLE. The document comes as one product of our REMR research program, which is a six-year program that I had calculated as we sat here finishing in 1989. It may turn out to be closer to the beginning of the year than at the end, but it will be in that time frame.

Mr. NOWAK. Well, it certainly raises a problem. We don't have this finalized. I assume that these criteria, however, are in use all over the country. Every project that the Corps does would require that they take on all of the criteria which were developed, and all of the analyses done prior to August of this year then have stopped. All of those projects would have to be reviewed based upon the new criteria that are contained in this draft that I have; isn't that correct?

Mr. DOYLE. No, sir. We are not stopping ongoing repair work, for instance, to reevaluate in midstream whether or not changes need to be made for that kind of work based on that report. Incidentally, I've just been told that that particular report is currently expected to be completed early in the next calendar year.

Mr. NOWAK. Well, how do you rationally, then, apply it to this project for the locks and not apply it to any other projects?

Mr. DOYLE. We are applying it to other projects, just as we did in Public Law 99–662, H.R. 6. We had to make a decision about when to start the new policy and for how long to let the old policy go. What we are currently envisioning is where we have ongoing work utilizing the old criteria, that work will continue. Where, however, we're talking about new work to be done in the future, we'll apply the new criteria.

Mr. NOWAK. I guess my question then: anything that has gone through a recommendation stage, if you will, as this lock had in 1985, the first recommendation to go ahead with the repair, I assume that all others would be treated the same even if it's a regular, ongoing maintenance problem? If it's a "new" part of that problem, you would apply this new material? Is it happening universally?

Mr. DOYLE. We are going to apply the policy to the same kind of work throughout our system under the same kinds of circumstances. This is not in any way a one-time shot with special treatment for Eisenhower-Snell and everybody else getting to operate under the old rule.

Mr. NOWAK. I assume this is a more conservative criteria development for all of your projects, then, throughout the country and we would be extending these new criteria, then, to every project even if it had been evaluated prior to this. If the work had not been started, you would go back and revise all of those documents

or those recommendations and review them based upon this new material; is that correct, John?

Mr. DOYLE. Yes, sir, so long as the work has not been done.

Mr. NOWAK. How many projects in the United States do we have that have been recommended but the work not started? Isn't that an awful large number?

Mr. DOYLE. I don't have that number here, but I'll be glad to provide that for you.

Mr. NOWAK. Mr. Chairman, maybe the committee would be interested in that as you look at the overall problem and as we look especially at all of the new work that has been authorized.

Mr. OBERSTAR. The Chair raised that question earlier and asked that that information be provided and included in the record at the appropriate point.

Mr. NOWAK. I wonder at this point—I don't want to take any more of the committee's time—if you could just give me a brief outlook as to what the Corps sees down the line as far as regular maintenance is concerned for this project? Is there a document that has schedules? Mr. Emery, perhaps you could——

Mr. DOYLE. Mr. Emery and his corporation have been doing in our view an outstanding job operating and maintaining both locks. I'm not familiar with the details of that program, but have been told by our engineers and experts that the work that's been done has been done very well.

Mr. NOWAK. Well, we will, I'm sure, hear a difference of opinion as to the advisability. I guess there is agreement, though, between the engineering firms and the Corps that under the new criteria, then, the maintenance would not be required at this time; is that correct?

Mr. DOYLE. The general maintenance would continue to be required to whatever extent is currently planned. What would not be required under the new criteria that would be required under the old is the major stabilization work that was envisioned in the two reports.

Mr. NOWAK. And your engineers, I assume, Mr. Doyle, feel very confident that there is no immediate problem based upon their inspection, or do you feel that more field work has to be done? When they lower that water out and dewater, is there going to be another look at this problem?

Mr. DOYLE. There is none currently planned that I'm aware of, but it strikes me that we ought to make sure that that happens. In the site visit that we had in August, we didn't have an opportunity to look at it in a dewatered state. We went up there and did the best we could under the circumstances, but we probably need to send somebody up there in a month or so when the water's out to see if anything is learned that would change the conclusions that have been reached so far.

Mr. NOWAK. I would hope that we would do that—continue to look at this. Even within the new criteria, if there is a problem, I guess you'd look at this lock in relation to other projects, and if another project fell, you'd have X amount of damage from the "misjudgment," but it wouldn't be as severe perhaps if we ever had to shut this down as occurred when the Canadians had the problems with their locks.

The only other thing I'd have to say is we really have to make an honest and good-faith commitment here. We note that the Canadians have, out of their general revenues, if not authorized, they've committed, if you will, $175 million in the next years ahead to stabilize their system of locks. So I hope we have the foresight to do everything we can to make sure that that investment is not down the drain, either, because if one of these locks ever should go, I would hope you would take as close a look at this as you possibly can because, as you well know, of the dire circumstances if we do have a failure.

Thank you, Mr. Chairman.

Mr. OBERSTAR. Thank you, Mr. Nowak. I greatly appreciate your insight as chairman of the Water Resources Subcommittee into this important issue.

Gentlemen, thank you very much for being with us. We really appreciate your time and effort, and we will look forward to continuing our review with you of the Seaway operations.

Mr. DOYLE. Thank you, sir.

Mr. EMERY. Thank you.

Mr. OBERSTAR. Our next panel includes Mr. G. Edward Dickey, Deputy for Program Planning, Review and Evaluation of the Office of the Assistant Secretary of the Army for Civil Works; and from the Corps of Engineers, Mr. Lloyd Duscha, Deputy Director of the Engineering and Construction Directorate; from the St. Lawrence Seaway Development Corporation, Mr. Stephen C. Hung, Chief of Engineering and Planning; and from Gannett Fleming Geotechnical Engineers of Harrisburg, Pennsylvania, Mr. F. James Knight, president, accompanied by Mr. John Diviney, project manager.

Gentlemen, please come forward.

Please raise your right hands.

[Witnesses sworn.]

Mr. OBERSTAR. Thank you.

My understanding is that the only member of this panel who has a prepared statement or prepared remarks to open with is Mr. Knight. If there are others, raise your hands and I'll recognize you for that purpose.

Now, Mr. Knight, would you begin with your prepared remarks?

TESTIMONY OF DR. G. EDWARD DICKEY, DEPUTY FOR PROGRAM PLANNING, REVIEW, AND EVALUATION; LLOYD A. DUSCHA, DEPUTY DIRECTOR OF THE ENGINEERING AND CONSTRUCTION DIRECTORATE; ROBERT J. SMITH, CHIEF OF THE STRUCTURES BRANCH; RICHARD F. DAVIDSON, CHIEF OF THE SOILS MECHANICS SECTION; JESSE PFEIFFER, RESEARCH AND DEVELOPMENT ENGINEER; HON. JAMES L. EMERY, ADMINISTRATOR, ST. LAWRENCE SEAWAY CORPORATION, ACCOMPANIED BY STEPHEN C. HUNG, CHIEF OF ENGINEERING AND PLANNING; AND F. JAMES KNIGHT, PRESIDENT, GANNETT FLEMING GEOTECHNICAL ENGINEERS, HARRISBURG, PA, ACCOMPANIED BY JOHN G. DIVINEY PROJECT MANAGER

Mr. KNIGHT. Yes, sir. Thank you very much.

Our firm was contracted by the St. Lawrence Seaway Development Corporation in May 1986 to perform an analysis of lock wall

stability for the Eisenhower and Snell locks. That study was to be an extension of the preliminary evaluation performed by the Buffalo District Corps of Engineers and completed in 1985.

We were directed to perform specific explorations, in situ and laboratory tests and detailed theoretical evaluations of wall stability. We were provided with extensive background materials including the Corps' 1985 report, construction plans and specifications, and copies of current Corps of Engineers' manuals dealing with the subject of study.

Our charge was to generally follow Corps of Engineers' criteria to determine if stability problems existed, to evaluate alternative corrective measues as appropriate, and to design rehabilitation works for the lowest-cost acceptable alternative.

Our firm has extensive experience with Corps of Engineers' projects. I have personally worked on assignments directly under contract for at least 10 different Corps of Engineers' districts over the last 25 years. We are familiar with Corps procedures, practices, and criteria. While we have always found the Corps to be conservative in their approach, we generally agree with that perspective and share with them that philosophy.

If you had asked me a year ago what, if any, disagreements I might have expected from the Corps on this assignment, I believe I would have told you that we might be questioned about not being conservative enough. Specifically, we have included in our analysis the forces related to shear resistance between the lock walls and the soil backfill. It has not been the Corps' past practice to do that. We did so because that force is real. It does improve theoretical stability, and by including it we could reduce the cost of repairs.

In reality, we have encountered difficulty in reaching a unified position with the Corps because they feel that we have been too conservative. While being complimentary of the overall quality and professional nature of our work, they have stated that we did not go far enough in the relaxation of standards. Not only do they believe we should have included the structure-to-backfill shear, but that we should have employed a less conservative method of analysis and that the acceptable safety factors for those structures should be lowered below normal limits.

We analyzed the Seaway locks by two methods: the limit equilibrium method and the shear friction method. Simply stated, the limit equilibrium method assumes that wall movements must occur to reduce the soil pressures behind the wall, while the shear friction method assumes that no wall movements will occur and utilizes measured soil pressures.

The resultant safety factors do not meet the Corps' standard criteria for either of those two approaches. While we found the lowest stability values using the sheer friction method, we believe that approach is the most appropriate for these structures. We believe that that is correct because we measured very high earth pressures behind the walls in our work the summer before last. Those pressures are higher than were anticipated in the original design, and they're higher than were estimated in the reconnaissance level study performed by the Buffalo District.

Further, those high pressures are still present despite the fact that the walls have already experienced some movement and par-

tial failure. All four walls, two at Eisenhower and two at Snell lock, were found in 1967 to have cracked. Those cracks were repaired by the Corps in 1968-69 at a cost of about $5.4 million. Anchors were installed across the cracks within the walls. It is important to note that the repairs did nothing to improve stability, but only induced the force across the observed failures to prevent additional crack propagation.

When we analyzed the lock walls using the earth pressures measued in our study and a finite element method of analysis, we found that the loads are still sufficient to cause the observed cracks and also that cracks may have occurred in another location within the walls where they are not observable and, therefore, may not have been detected.

Engineering problems inherent in the situation include, one, the presence of the high earth pressures which we measured by two confirming methods; two, the fact that the wall movements which have already occurred have not removed those pressures; three, the indeterminate amount of movement required to lower the pressure; and, four, the indeterminate amount of movement necessary to cause a disabling failure of the lock.

We have two basic differences of opinion with the Corps' current position. First, the Corps has stated that the sheer friction method of analysis which we employed is too conservative. They hold that the high earth pressures we measured will be reduced by small and acceptable movements. Therefore, they believe that the limit equilibrium approach which does not include the application of earth pressures is more appropriate. We contend that the amount of movement necessary to achieve earth pressure reduction and the allowable movement of walls before a systemic shutdown of the Seaway occurs are both unknown and indeterminate. We, therefore, believe the method of analysis utilized, and which has been for many years the Corps' employed approach to similar problems, is correct for this case.

Our secondary disagreement is that the Corps has proposed factors of safety below their normally-accepted range for these structures. Their draft engineer technical letter, which was derived from the REMR work which has been discussed previously and which covers stability criteria for existing concrete navigation structures on rock foundations, states that standards may be lowered, and I quote, "when the remaining life of the structure is relatively short or when there are no indications of any stability problem."

While we basically concur with the philosophy of lowered factors of safety for existing structures in some circumstances, we are troubled by the application of that approach in this instance. The Seaway's locks are clearly expected to have a long-remaining life. They clearly are critically important structures. Further, we believe that the previously-described cracks are indicative of stability problems. Our analysis shows that the earth pressures which caused those partial failures are still there. We conclude that the continuation of that condition may lead to more serious consequences. We, therefore, cannot endorse the relaxation of accepted and longstanding criteria for this instance.

In conclusion and as stated in our letter to the Seaway dated September 14th of this year, in our opinion the Eisenhower and Snell locks do not possess adequate reserve strength to assure that failure will not occur. While we cannot say that failure is imminent or that it will, in fact, occur, neither can we give assurance that failure will not occur. The margin is too close for us to not, therefore, recommend corrective actions to restore the factors of safety to current accepted levels.

Mr. OBERSTAR. Thank you very much, Mr. Knight, for that very clearly-expressed analysis of the lock wall situation, for the very deliberate and clear way in which you presented your findings and your judgment.

Let me ask the Corps engineering panel: when the onsite review was conducted, did that review include a test of earth pressures and movement and attempt to make an analysis of any indication of failure, whether partial or measurable to any extent?

Mr. DUSCHA. Mr. Chairman, during the course of the field trip and before and after, the test results that had been obtained through various soil explorations were reviewed. At the site the team paid particular attention to looking at the conditions at the top of the walls, the surficial conditions around the top of the lock, to see if there was any evidence of distress which could be caused by an overturning or a sliding condition.

Mr. OBERSTAR. How were those measurements taken?

Mr. DUSCHA. The team did not take any measurements. We relied on the measurements that had been taken by the St. Lawrence Seaway Corporation periodically over some number of years.

Mr. OBERSTAR. Was there—there were no borings made, no other type of physical analysis?

Mr. DUSCHA. There were some borings made. The team reviewed the borings, yes.

Mr. OBERSTAR. The borings were made during the time of that field survey?

Mr. DUSCHA. No, not during the field——

Mr. OBERSTAR. Not during that onsite survey, but that formed the basis for that——

Mr. DUSCHA. Correct.

Mr. OBERSTAR [continuing]. Seaway information?

Mr. DUSCHA. Yes, borings were made under the REMR program and also there were borings made by the Seaway Corporation.

Mr. OBERSTAR. Those findings, then, were subjected to a computer analysis, as I understand—as I read from your several documents? To what analysis were those Seaway figures and database—in what way were they analyzed?

Mr. DUSCHA. Basically analyzed——

Mr. OBERSTAR. You developed a computer model as a result of—that word is referred to in this draft April 1987 report. Several times "computer model" is referred to in there. Is that how this information was analyzed?

Mr. DUSCHA. We did——

Mr. OBERSTAR. Or, if not, then just tell me how it was—in what way it was done.

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Mr. DUSCHA. We did run a stability analysis on the data that we had using a computer and comparing that to our new criteria, methodology, and so forth.

Mr. OBERSTAR. If the same engineers were to go into the lock when it is dewatered, what is the likelihood they will find some different information?

Mr. DUSCHA. Well, offhand, I don't think we'll find anything different. It would seem that what we're looking for should manifest itself on the top surface in some form, but at the same time I wouldn't want to be denied the opportunity to look at the lock when it was dewatered.

Mr. OBERSTAR. That would round out the evaluation of the lock, so to speak; is that right?

Mr. DUSCHA. Yes.

Mr. OBERSTAR. Would you feel more sure of your conclusions if borings were taken to determine compression and to evaluate the effect of the compaction and the tension that exists in that backslope?

Mr. DUSCHA. Well, I think Gannett Fleming has done exactly that in their type of analysis. Basically I think the only point of disagreement we have with them is how the data are applied. We don't disagree with their results of those borings. It's just a matter of how you apply those results to the monolith.

Mr. OBERSTAR. Well, then, describe for us what is your disagreement with the results. You accept as given data the matter of friction, the matter of tension, and the other data. You have evaluated that information in a different way. Now we're talking about vertical force, horizontal force, force U, force N, and force T, which I am taking out of your draft. Those are the criteria?

They put those all into a computer and you came up with a different result than you did using some other formula for evaluating these results?

Mr. DUSCHA. Than a formula we used several years ago, yes.

Mr. OBERSTAR. Yes.

Mr. DUSCHA. Correct.

I think it goes back to the two basic differences that Mr. Knight pointed out. He put the problem in very good perspective there when he said, one, that the high earth pressures--we feel that the high earth pressures will be reduced by a small——

Mr. OBERSTAR. Would you just take that microphone and bend it down a little bit. Now it's at your speaking level.

Mr. DUSCHA. We feel that the high earth pressures that he referred to will be reduced by a small movement of the wall. Mr. Knight has a different opinion on this particular aspect.

Mr. OBERSTAR. What does a small movement of the wall mean?

Mr. DUSCHA. Basically we feel that almost any movement of the wall will give you some relief in the basic earth pressures.

Mr. OBERSTAR. Movement inward?

Mr. DUSCHA. Yes.

Mr. OBERSTAR. And is that good or bad?

Mr. DUSCHA. Well, I can cite some experience. Basically, we have one wall that has moved 10 inches on one of our locks and the lock is still operational.

Mr. OBERSTAR. Yes, but if it moves inward 10 inches, on an 80-foot beam ship it further reduces the leeway that vessel has within that lock, doesn't it?

Mr. DUSCHA. Well, it does that.

Mr. OBERSTAR. Yes. Just a little bit of a wind on the superstructure can move it over enough to put some damage in the hull and in the lock wall itself; isn't that right?

Mr. DUSCHA. That's true if the lock width becomes too narrow, but I don't think we're looking at movements of 10 inches in this particular wall.

Mr. OBERSTAR. I sure hope not. That would send shudders through all who are operators of the Seaway.

Mr. DUSCHA. And then the other factor that he raised, that the factors of safety were below the Corps' range, and that is true. After looking at existing structures, we have decided that the factors of safety for existing structures as compared to new structures could be reduced somewhat based on the experience with the structure and other factors.

Mr. OBERSTAR. In fact, you don't disagree with what I said at the outset of the hearing—that these structures were built very conservatively; they have been evaluated very conservatively. They're still standing. They haven't collapsed. Monoliths haven't moved. So now it's time to say we've been looking at this thing too conservatively; let's have a more liberal standard by which to evaluate.

Mr. DUSCHA. No, I don't think I'd put it in the terms of a more liberal standard. I think——

Mr. OBERSTAR. Less exacting.

Mr. DUSCHA. No, not even that.

Mr. OBERSTAR. Well, how do you—if you're relaxing the standard by which you've operated, how do you characterize it then?

Mr. DUSCHA. I think basically when you're looking at factors of safety you have to consider how many knowns you have in the equation. The more knowns you have, the lower the factor of safety one can be content with. I think that's what we're doing here.

An existing structure in itself gives you some idea of how effective it is.

Mr. OBERSTAR. Well, all right——

Mr. DUSCHA. The more unknowns in an existing structure, the higher the need margin of safety.

Mr. OBERSTAR. Exactly. That's what we deal with in almost all of the work of this subcommittee: the margin of safety, the cushions that are built into air traffic control, bridge design, the amount of redundancy that is built into a system to assure safety against a number of unknowns that mind of man or effort of computer cannot at this time foresee or calculate. We find that safety takes a nosedive as those margins of safety are reduced, as those built-in cushions are removed. What we're concerned about now here is that factor of safety. What factor of safety in that numerical form in which the Corps expressing this type of thing—what factor of safety was assigned to the seaway locks?

Mr. DUSCHA. Well, basically let me approach that another way, I think. The difference in the factor of safety that I'm talking about in this particular case is that for sliding stability under the criteria

that Gannett Fleming used and which we have published as Corps criteria, we used a factor of safety of 2.

Mr. OBERSTAR. Yes.

Mr. DUSCHA. Under this new look that we have adopted for existing structures, we feel that a factor of safety of 1.6 would be adequate in this particular case.

Mr. OBERSTAR. Now is the factor of safety of 1.6 going to be applied in the future to all existing Corps structures to be considered for rehabilitation?

Mr. DUSCHA. This will be true for existing Corps structures. In fact, we have applied it to a number of structures that we have analyzed. This is not the first structure that we have taken a different look at.

Mr. OBERSTAR. Could you give us just a few examples off the top of your head—or off those sheets that you have at hand?

Mr. DUSCHA. Yes. Basically, we've applied these criteria to lock and dams No. 4, 5, 7, 8, 9, and 10 on the Mississippi River—so that's a total of six locks and dams on the Mississippi—and we've applied them to one lock and dam on the Ohio and to another in Virginia.

Mr. OBERSTAR. And you've not found those locks wanting?

Mr. DUSCHA. Not yet.

Mr. OBERSTAR. Not yet. A normal factor of safety is 2; is that correct?

Mr. DUSCHA. Yes, under the criteria that were being used.

Mr. OBERSTAR. This is about a 20 percent reduction in factor of safety.

Given the strategic importance of these locks—on the Mississippi there are ways of getting around a problem, but given the strategic location of these locks, did you give consideration to retaining a higher factor of safety?

Mr. DUSCHA. Basically, we felt that the factor of safety here was adequate for these locks. I might add that you can't get around the Mississippi locks, either.

Mr. OBERSTAR. Well, I guess there are some places where you really can't get around them; that's true. You could probably unload them and put them on rail—unload the barges and put them on rail.

Mr. DUSCHA. You do have a different situation, I'll concede that, because you have a different type of traffic in which you can use alternatives,.

Mr. OBERSTAR. So the factor of safety you're now applying to Mississippi locks is 1.6?

Mr. DUSCHA. Yes, that's the case for this type of analysis.

Mr. OBERSTAR. Mr. Hung, in response to a question in our hearing last summer, you described the Corps' factor of safety saying:

> Where the materials are highly variable in quality or the strengths of those materials are difficult to quantify reliably or where strengths may vary within a wide range, and/or where the consequences of a failure are serious, the recommended allowable safety factors are usually much higher than 1.0.

Now what did you mean by that description? Is that an accurate reflection of a Corps factor of safety standard?

Mr. HUNG. Yes, Mr. Chairman. Although Gannett Fleming did come in last summer to do quite an extensive soil boring and test-

ing, in no way I can say for sure all the backfill material is uniform. I think everybody at this table in the Corps would also agree with that. I think that's what I mean: even though we've done a lot more tests, we still feel—it's not like, let's say, designing something else—you know exactly what kind of material, tested the concrete strengths or something like that—this, the soil parameter still has something we really cannot say for sure. So based on that philosophy, we just don't think a relaxed criteria should be used. We'd like to have more factor of safety.

Mr. OBERSTAR. Do you feel comfortable with this down-rating of the factor of safety as an engineer? You have worked on Corps' projects, both you and Mr. Knight. What are your feelings about the factors that have been included in the Corps' decision to change their factor-of-safety rating?

Mr. HUNG. No, I do not feel comfortable to lower the factor of safety for this particular structure. The other thing that concerns me is that particular criteria is still in the draft form, and that means maybe within a year—as I understand it, they are still getting the input from their district office, and they are going to apply to their own structure. Now something could happen to the structure and then they could completely reverse their draft ETL, it seems like. Personally, I just don't think, until that thing is finalized, it should be applied to such a critical structure.

Mr. OBERSTAR. Thank you.

Mr. Knight, do you have a comment?

Mr. KNIGHT. Mr. Chairman, I don't agree with the application of lowered factor of safety for this project for two reasons: First, because of its critical nature, and I fully understand that situation. I am a native of the Great Lakes area. I was born and raised in Michigan. I grew up on the shores of the Straits of Mackinaw and attended college for two years in sight of the locks at Sault Sainte Marie. I think I have a good comprehension of the importance of this Seaway facility to the United States and to the Great Lakes States in particular. This is a critical structure, and I don't think that relaxation of criteria in a marginal situation is appropriate for this kind of an application.

The second reason I don't agree with the relaxation is, to follow on what Mr. Hung has said, there are a number of uncertainties involved in the analysis of this lock, and one of the critical ones being that in our opinion the lock—both locks have already suffered some partial failure. Now not everyone looks at the cracks that occurred as being indicative of a failure, but in fact certainly the structures were not designed to crack and they have cracked.

When we did the analysis, we found that the high earth pressures that are still there are sufficient to cause those cracks to occur, and in fact that they may have caused the locks to crack in another location where there's not accessibility and you may not have been able to detect it. So in our mind there are a number of very critical questions that make this a very marginal situation where we don't think relaxation of criteria is appropriate.

Mr. OBERSTAR. You do say in your statement, "We concur with the philosophy of lowered factors of safety for existing structures in some circumstances."

Mr. KNIGHT. Yes, sir.

Mr. OBERSTAR. "We are troubled by the application of that approach in this instance because of the critical nature of this particular lock and location of that lock."

Mr. KNIGHT. Yes, because of the critical nature and because, sir, in our opinion, the locks are indicating some symptoms of stability problem. We think the cracks are indicative of that. If the lock is clean, if there's no indication of problem, if it's a low criticality, a relatively short life expectancy, we agree completely that lowered criteria are appropriate. We don't think that fits the circumstance here.

Mr. CLINGER. Would the gentleman yield?

Mr. OBERSTAR. Mr. Clinger—yes.

Mr. CLINGER. I just want to pinpoint what you mean by critical nature. Are you referring to the economic consequences of a failure? Or, are you referring to some uniquely critical features of this particular structure?

Mr. KNIGHT. No, sir. I'm referring to the economic consequences of a failure to the national security and to the economy of particularly the Great Lakes States.

Mr. OBERSTAR. I'm going to yield to the gentleman from Pennsylvania. I just have one further question at this point. I'll have others later.

As we review this report, what are the principal criteria, the factors that influenced upon this reconsideration of longstanding criteria? What are the principal factors that have caused the Corps in this REMR study to move away from the more conservative evaluation to a lowered standard that you are now proposing and now applying, in effect, to existing locks? What are the principal elements that—describe those in laymen's terms from the diagrams here that appear in the back of this document that are referred to throughout.

Mr. DUSCHA. I think basically it's governed by one principal element, Mr. Chairman, and that is the fact that over the years we have observed that a number of locks designed under previous criteria were not having any problems. So we have based our decision on the fact that historical experience could enable us to use some judgment factors.

Even though the situation indicated that the locks did not meet the factor of safety computationally, the locks were still standing without any evidence of distress. So we had to conclude that perhaps the factor of safety was a little bit conservative and could be lowered to a certain extent to recognize this factor and other factors involved.

Let me make one other point on this REMR report that you are referencing. These conclusions that I just cited really preceded the REMR report. The REMR is sort of a confirmation of the thinking that we had, and we wanted to confirm this thing.

Mr. OBERSTAR. The thinking that you've had that has been in progress for some time prior to undertaking the REMR report?

Mr. DUSCHA. Yes; that is right. We probably started looking at something like this in 1981 as to whether we are being overconservative.

Mr. OBERSTAR. If you apply this less conservative approach—I won't say more liberal, but let us say less conservative approach—

do you have any idea—have you undertaken any analysis of plans for rehabilitation—of the amount of money that might be saved by not engaging in major rehab work if a more conservative criteria were applied?

Mr. DUSCHA. I'm sorry, Mr. Chairman, we have not run any computations on the dollar values that we would gain by this. All I could say is that there certainly would be savings involved in this approach.

Mr. OBERSTAR. In this case, $18 million to somebody, whether it's to the Corps or to the Seaway, but most likely it would have come out of the Seaway's pocket or out of the Department of Transportation's pocket, out of the taxpayers' pocket.

I'll have other questions, but I will at this point yield to the gentleman from Pennsylvania.

Mr. CLINGER. Thank you very much, Mr. Chairman.

Thank you, gentlemen, for your testimony here. I think we've got an honest disagreement, a difference of opinion on this issue. As I've already indicated, it's difficult for a layman to really understand what the dispute is about, much less who might be right in the dispute. But let me try at least to get a little better understanding of the nature of the dispute.

Mr. Knight, are you suggesting that, in essence, the analysis, the ongoing analysis being undertaken in the REMR project is sort of shoot from the hip? Is it fatally flawed or is it only inapplicable and should be not applied in this instance?

Mr. KNIGHT. Mr. Clinger, I don't think that research is shoot from the hip at all. I think it's very scientifically-founded, good research. My disagreement is with the application of those criteria to this structure, and I refer to what is included in the REMR documents and in the Corps' own guidelines as being my reason for not wanting to apply that criteria to this lock.

The criteria for application include existing structures with no indication of stability problems and where the critical nature of the system—and I refer again to the economic consequences and all that goes with that—are low. I don't find that those criteria fit this lock. I believe, and it's our collective belief—and there are other consultants who worked with us on this evaluation—that these lock walls are exhibiting some inherent stability problems. They cracked. They did that some years ago. They did that as a result of the earth pressures that are existing there now. That to us is indication of a problem.

Mr. Duscha refers to partly what led them to the conclusion that criteria could be relaxed is examining many existing structures without evidence of distress, and those were his words. We think there is evidence of distress. Five and a half million dollars was spent in 1968–69 to keep those cracks from propagating further. We think that that's indicative of a stability problem.

The other factor is certainly these are important structures. We think they are important to the extent where lowering factors of safety, lowering criteria are inappropriate.

Mr. CLINGER. Do I understand that repairs to cracks were made both at the Eisenhower and the Snell structures?

Mr. KNIGHT. Yes, sir, both walls at both locks have cracked.

Mr. CLINGER. Have cracked?

Mr. KNIGHT. Yes.

Mr. CLINGER. Now there are no cracks visible at the present time; is that right?

Mr. KNIGHT. Well, the cracks are not visible from the surface, sir. They're——

Mr. CLINGER. That's what I was going to ask you. You've talked about internal cracks. Have you confirmed that there are such cracks, and how did you do that?

Mr. KNIGHT. Yes, sir. You can see them. If you go into the inside of the lock when it's dewatered, into the filling and emptying culvert, the cracks are there. You can see them. We were in the Snell lock last winter when it had been newly dewatered, and there was water pouring down through the wall from the outside from a crack that exists the entire length of the lock. Now they know, the Corps knows, that that crack is there. They examined it in 1967. In fact, my understanding is that they were so concerned about it that there was consideration for shutting the lock down until repairs could be made. I wasn't involved in that analysis, so I don't know all the facts, but they did do a repair to repair that structural failure.

Now it may be a matter of perspective whether that crack is a stability problem or a structural one. Certainly it is a structural one. It did crack. We think it is also indicative of a stability problem and that the wall is not moving as a total unit in that instance, but the top part of the wall deflected and caused a crack.

You can see them, sir. They are there. They are very real.

Mr. CLINGER. I understand that they are going to dewater the Snell lock this winter?

Mr. KNIGHT. Yes, sir.

Mr. CLINGER. And presumably at that point you'd be able to determine if the crack had grown larger or stayed the same or was——

Mr. KNIGHT. We will be able to examine it, sir, but repairs were made to keep that crack from changing. That's the $5.5 million that was expended. But that didn't do anything to change the stability of the wall; it only stopped the propagation of the crack.

Mr. CLINGER. I see. So with regard to the sort of criteria established thus far under the REMR project, you're not suggesting that those criteria applied in other areas would be—that we would be subjecting ourselves to unacceptable risks in other areas? It's just that you pinpoint these two as being places where they should not be applied?

Mr. KNIGHT. Yes, sir, I believe that's correct. I concur with the findings of the REMR report. I think their guidelines are appropriate. I think perhaps it is appropriate to look at relaxed standards under some circumstances. My argument is with this circumstance.

Mr. CLINGER. Right. I just want to follow up a bit on that. You did talk about the possibility of favoring lowered standards in some instances. I think you said it was in those instances where the structure was nearing the end of its useful life, but it would seem to me that that might be the very time when you would not want to lower the standards because of the fact that it was older and, therefore, perhaps more likely to fail?

Mr. KNIGHT. Well, certainly you have to look at the circumstances, sir. If it is a temporary structure, perhaps there is some room to gamble. With a permanent structure with a long life expectancy ahead of it, as the Seaway locks are, I don't certainly think that's the time to be gambling.

Mr. CLINGER. Mr. Duscha, Mr. Knight has said that he feels that the cracks indicate that the wall is not moving uniformly and that, therefore, that should raise a red flag that you haven't taken into account. Has the wall moved, in your opinion, in recent years?

Mr. DUSCHA. Going back to what Mr. Knight said, it is a matter of application of the criteria to this structure. I think he stated it very well. We look at the cracking that Mr. Knight referred to as a structural problem and not necessarily as a stability problem. So we do have a difference of opinion on that particular issue; this is true. As such, then if he looks on this as a stability problem, then he has to come to the conclusion that he has come to. I can't discount that.

Mr. CLINGER. What you are saying is that the crack does not undermine the integrity of the wall itself?

Mr. DUSCHA. That's right. We look at it as a structural problem of the wall and the filling system which has been successfully repaired.

Mr. CLINGER. And that, therefore, the repairs which you effected 2 or 3 years ago to prevent or hopefully stop any additional cracks, or the crack from getting any bigger, are sufficient?

Mr. DUSCHA. Yes. In fact, going a little bit further, the high earth pressures that were mentioned here should certainly be used in analyzing the structure, the walls from a structural standpoint. We agree with that.

Mr. CLINGER. Did you tell me whether you had any measurable movement of that wall so far?

Mr. DUSCHA. Well, there has been some measurable movement, but the way we analyze that, it's only that movement which you expect from filling and emptying of the lock, and seasonal type movements.

Mr. CLINGER. But you do not contemplate that is going to move because of the earth pressure?

Mr. DUSCHA. Right now we do not contemplate any degree of movement.

Mr. CLINGER. OK. Are the Snell and the Eisenhower of equal in terms of age, condition, et cetera?

Mr. DUSCHA. Well, the Eisenhower lock has a different quality of concrete in it, but I think that's been addressed and taken care of. Otherwise, I think you'd consider them as comparable types——

Mr. CLINGER. So you feel that there's no differential then in the safety factor that should be applied to one over the other; they could both be lowered to the same degree, in your opinion.

You stated that you felt that you could lower the safety factor without running any risk. Are you saying that you contemplate that you could lower it to where you were planning to lower it and we would still have no failures, or do you contemplate that we might have a failure somewhere along the line?

Mr. DUSCHA. We cannot see a failure due to stability in the foreseeable future. Things change over time, and you have to keep looking at structures of this magnitude for possible happenings.

Mr. CLINGER. Right.

Mr. DUSCHA. I'm not discounting that.

Mr. CLINGER. Let me ask you one of the questions I asked Mr. Doyle: your determination, as I understand it, is based upon research results obtained in the Virginia Tech investigation which was under contract to the Corps of Engineers. Have those findings, to your knowledge, been validated from any other source?

Mr. DUSCHA. We have had them reviewed by our own experts in this field.

Mr. CLINGER. And they confirm the accuracy of the findings?

Mr. DUSCHA. Yes.

Mr. CLINGER. One other question, Mr. Knight: you referred to two types of tests, one of which the Corps has now rejected and which you feel should still be utilized in this case, and then you referred to tests which they were now going by. Can you describe those to me a little bit so that I have a little better understanding.

Mr. KNIGHT. Yes, sir. It's not two different types of tests. It's two methods of analysis, two approaches to a theoretical determination of stability. We used a shear friction, a method that's called a shear friction type of analysis.

Mr. CLINGER. Was this an analysis which was utilized by the Corps heretofore?

Mr. KNIGHT. Yes, sir, it was. It has been the standard for them and for the rest of the industry for some years.

Another approach is the limit equilibrium approach. We have a basic difference of opinion as to which is applicable. Our contention——

Mr. CLINGER. With the second approach, you don't feel it was applicable in this instance. Would it have validity in other instances?

Mr. KNIGHT. Yes, sir, it could have. I would just reinforce a statement again, sir, that when analyzing the stability of these walls with the parameters that we have determined and which we understand the Corps is in basic agreement with—they don't disagree with the measured earth pressures and the other factors that were employed, and have stated that—when you use either of those two methods of analysis, you get factors of safety which are below their current accepted criteria. So, in other words, you have to be considering a modification or a relaxation of criteria under either of those approaches.

The shear friction method, which is the one we believe is the most applicable, in fact provides factors of safety that are for the structures as they now exist slightly lower than the limit equilibrium analysis that they believe is appropriate. Now we contend that we are in a marginal situation; that it's a very close issue to call; and because of the critical nature of these facilities, we don't believe it's prudent under that kind of a circumstance to be relaxing. It's just too close for us to call.

Mr. CLINGER. Mr. Duscha, why do you feel that the analysis, the procedures that you are following are more appropriate than Mr. Knight seems to feel they are?

Mr. DUSCHA. I think under any circumstances one has to be concerned with the margin of risk in the call. I wouldn't want to discount that at all because this is what we're all concerned with.

In this particular case, though, I think we have some historical evidence to indicate that the factors of safety can be lowered. In fact, at this particular lock we haven't seen anything that would indicate that we couldn't lower those factor.

I might assure you that had we noticed anything there which would cause us to be suspicious, we wouldn't have taken this position by any stretch of the imagination. It's kind of unusual for me to be sitting here and talking about lowered factors of safety when throughout my career I have been accused of being too conservative.

Mr. CLINGER. Yes, that is interesting. I guess that's why the subcommittee raises a concern that maybe budgetary concerns are more of a factor here, but you would reject that?

Mr. DUSCHA. No, I would not indicate that budget concerns were a factor in making that decision. I think Mr. Dickey will attest to this in my pursuit of dam safety matters.

Mr. DICKEY. Yes, I certainly can, Mr. Chairman, attest to his conservative approach.

Mr. CLINGER. Thank you very much, Mr. Chairman.

Thank you, gentlemen.

Mr. OBERSTAR. Before I call on Mr. Nowak, I just want to ask one question: Is the REMR study or report guidance for district and division engineers or is it directive for division engineers?

Mr. DUSCHA. Basically the report as such is neither. What we tend to do with reports of that nature is to put out a publication either an ETL, an engineering manual, or something which would be guidance to the field.

Mr. OBERSTAR. So it's guidance, but it is a standard against which the district engineer should measure each project based on his analysis of the specific and peculiar conditions of that particular structure?

Mr. DUSCHA. Absolutely. You don't want to take this as a cookbook solution. You have to apply it to the particular case at hand and show judgment on that basis.

Mr. OBERSTAR. To be fully applicable to the Eisenhower and Snell locks, the Buffalo District engineer ought to go up there during dewatered conditions and look at that lock, probably take some borings, do some other tests which I don't have at my fingertips, and then measure the results of what he has found on site against 1.6 and decide whether it needs this additional work or not?

Mr. DUSCHA. I would agree that the Buffalo District engineer should inspect the locks when dewatered. I'm sure that we from this particular headquarters would also be interested in participating in that inspection.

Mr. OBERSTAR. Thank you.

The gentleman from New York?

Mr. NOWAK. Could you explain—I missed a few words here—what is the effect of this draft? It's not a directive to be used by your field officers in evaluating?

Mr. DUSCHA. This is a report prepared by the consultant that we hired. Basically, to implement these things, we need another instrument which comes out of the headquarters which references this material and advises the field how to apply the material.

Mr. NOWAK. But this has been used by all your field officers now to evaluate or reevaluate the plans that had already been evaluated under the old criteria in 1985 in this instance, and I assume that locks 2, 3, 5, 7, 9, and 12 in the Mississippi?

Mr. DUSCHA. Right, because we had what we call an engineer technical letter in draft form to the field indicating to look at locks in this revised manner.

Mr. NOWAK. This is the document they use?

Mr. DUSCHA. Yes.

Mr. NOWAK. Can you tell me on locks 2, 3, 5, 7, 9, and 12, have they all been changed from the previous reports that they had for the work on those specific locks because of this draft?

Mr. DUSCHA. Not because of this draft that you're looking at there. They were changed or analyzed differently by virtue of the draft engineer technical letter that we had sent out back in 1984, I believe.

Mr. NOWAK. But they were changed?

Mr. DUSCHA. They were analyzed differently.

Mr. NOWAK. Did that result in any changes?

Mr. DUSCHA. No. It was found that we did not have to make any physical changes in the locks.

Mr. NOWAK. Well, then all of that work has proceeded as it was originally under the old criteria?

Mr. DUSCHA. It was designed under the old criteria and if you use the old criteria——

Mr. NOWAK. Are the Eisenhower and the Snell locks the only changes that you're aware of because of these new criteria or the letter reflecting these new criteria out to the districts?

Mr. DUSCHA. No. Basically, our draft ETL or engineering technical letter applies to all.

Mr. NOWAK. But none of the others were changed?

Mr. DUSCHA. None of the others had to be changed when the revised criteria were applied.

Mr. NOWAK. The only "real effect" of this has been on the Eisenhower and Snell locks, as a practical matter?

Mr. DICKEY. Excuse me, Mr. Chairman. There is a little miscommunication here. I think the question of change is referring to a change in the structure as it exists. What Mr. Duscha is saying is that when the new approach was applied to those other locks, they were found not to need rehabilitation, just as Eisenhower and Snell were found not to need rehabilitation.

Mr. NOWAK. Oh, all right. So those other locks, then, have not been rehabbed based upon the new criteria?

Mr. DUSCHA. That's correct.

Mr. NOWAK. Is that correct? And do you know the amounts of money that have been, therefore, not appropriated for that previously-designed work?

Mr. DUSCHA. As I indicated to one of the chairman's questions, I do not have these figures. We could develop some figures for you on these particular locks where we have applied it and not found

the need for physical correction or rehabilitation. If the committee would like that, we'd be happy to furnish that.

Mr. NOWAK. This draft, I think I heard in an answer to another question, was being prepared as early as 1981; is that correct? It started——

Mr. DUSCHA. No, not that particular draft. We started looking at an approach like this in 1981.

Mr. NOWAK. This was a result of the studies looking for that new approach?

Mr. DUSCHA. This is part of the studies to confirm that approach, yes.

Mr. NOWAK. The Eisenhower-Snell locks you have not found instability in reviewing the information that has been supplied by the Gannett Fleming firm to provide any evidence of instability; is that correct?

Mr. DUSCHA. Yes, we see no evidence of instability on the present locks.

Mr. NOWAK. What would a factor of instability show up as under the Corps' new criteria? If that crack were 6 foot wide, would that be instability, or do you need leaking? What do you need for instability of a massive lock this size?

Mr. DUSCHA. Basically, instability shows itself up primarily in cracking as one evidence and movement in some form.

Mr. NOWAK. There's been no measured movement that you consider——

Mr. DUSCHA. Not that we could lay to instabilities.

Mr. NOWAK. Just as an option—and I don't know if anybody can answer this; I'm sure you've had some people review what happened up in the lock—what lock was it up in the Welland system, the two of them——

Mr. HUNG. Lock 7, sir.

Mr. NOWAK. There were two locks, right, weren't there, that had problems? One lock. The lock that, everybody used the word, caved in—was that the lock, somebody had mentioned, that had been inspected some short time before by the Canadian team of inspectors and found to be, as they said, stable. They had that problem.

Is there any—do we know how that lock collapsed like that?

Mr. DUSCHA. Yes. I think we have a totally different condition at the Welland lock than we're talking about here.

Mr. NOWAK. We're in no jeopardy of that?

Mr. DUSCHA. No, we don't have the same situation here at all.

Mr. KNIGHT. We concur, sir. The two circumstances are not parallel.

Mr. NOWAK. What caused the Canadian collapse?

Mr. DUSCHA. Basically it was a structural failure between the face of the wall and the penstock for carrying the water. It just blew out.

Mr. KNIGHT. There was a penstock that went down through the wall that carried water to a hydroelectric generator. Because of a surge condition within the hydraulics of that system, a piece of that wall blew out into the lock. It's a different circumstance than we're looking at.

Mr. NOWAK. Well, I would hope at the very least as we go through this, whether or not the historical experience certainly has

shown that the Corps has a pretty good record of their maintenance of these tremendous structures that we built in the United States over many, many years—we have, I think, at the same time a situation here where we have an older lock and perhaps, I assume anyway, the new criteria takes into consideration the age and whatever other factors have to be taken into consideration at this point in time. I would only again say if we err, we'd better err on the side of safety because there are tremendous economic consequences of something happening to this lock, and certainly it would be a great—this record would be a great record for an attorney suing the United States as the Canadians are now being sued. Although that litigation is not completed, I would think there are several hundred million dollars worth of claims pending, and I would hate to be put in a position of being less than prudent in the circumstance.

I can understand the disagreement. I don't know if we should call for an arbitrator to come in; I don't know if there is one that could narrow these differences or the degrees that are looked at here, but I would hope that the Corps would give and take every opportunity to re-establish, if they will, their view at the present time when that dewatering takes place and they have an opportunity to do every possible test that could confirm their decision.

Thank you, Mr. Chairman.

Mr. OBERSTAR. Thank you, Mr. Nowak.

I certainly underscore the point the gentleman from New York made, and did so in my opening remarks—that when a collapse or a major event may occur in this lock, we don't want to be dispatched up there with this little document, stick it in the crack and say "Please hold." It won't do it. We don't want folks to be looking around and pointing fingers of blame. It's too late then—$500 million or more worth of damage would have been done.

In the Engineer Technical Letter No. 1110-2, which is not dated, a copy of which I have, which I'm sure you're familiar with, on page 1, it says:

> The following procedure shall be used in the evaluation of current stability conditions and in the determination of necessary corrective measures. They should be considered as guides and are not intended to replace engineering judgment by the engineers responsible for the project.

I think you and I covered that somewhat in an earlier question, to which you said, yes, anything in REMR would have to be verified, evaluated by the engineer onsite.

Page 2 describes steps to be taken in conducting that analysis, and toward the bottom of paragraph (a):

> Friction between the backfill and wall or on a plane within the backfill may be considered in the stability analysis of existing structures. Recent REMR research indicated that neglecting wall friction is unnecessarily conservative.

What is the significance of wall friction? Why is it unnecessarily conservative to exclude the factor of wall friction from your safety consideration?

Mr. DUSCHA. What we have found in reality is that we have this force acting on the structure which we feel we ought to use in the analysis. By virtue of using that particular force, you do increase your factor of safety.

Mr. OBERSTAR. And, thereby, reduce the number from 2 to 1.6?
Mr. DUSCHA. No. No——
Mr. OBERSTAR. It's not that simple?
Mr. DUSCHA. No.
Mr. OBERSTAR. All right. How do you get from 2 to 1.6?
Mr. DUSCHA. Well—you make the computational analysis, you come out with a figure, and then you compare it to the 2 and the 1.6. But it leads you—it's part of the computation that leads you to determining what the factor of safety is for that particular structure.
Mr. OBERSTAR. Why has that factor, wall friction, been excluded from earlier analyses and why now do you think that it's significant and this factor should be included?
Mr. DUSCHA. Well, basically it's been found through research—and this is pointed out in this particular REMR report that you're looking at—that this is a real factor. As a consequence, if it exists, it certainly should be utilized.
Mr. OBERSTAR. Because locks haven't collapsed using these criteria, we are too conservative, and here is one of the factors why that——
Mr. DUSCHA. This factor was neglected in the past. This is a matter, I think, of state of the art and developments as time goes on. You know, with various instrumentation and various knowledge, be it parametric or be it something empirical, you gain some experience that you can apply.
Mr. OBERSTAR. Mr. Hung and Mr. Knight, what is your reaction to the factor I cited?
Mr. KNIGHT. We concur with that, sir. In fact, we did the analysis. We used the Corps' traditional method, but we added that factor to our analysis. So we concur with it. We agree that that force should be included, and we added it to the analysis when we did it.
Mr. OBERSTAR. And you still came with a different result?
Mr. KNIGHT. We still get results that are under the Corps' standard criteria; yes, sir.
Mr. OBERSTAR. What factor are you including that the Corps does not?
Mr. KNIGHT. Well, the basic disagreement, sir, has to do with what happens with the high earth pressures behind the wall. Mr. Duscha has stated that——
Mr. OBERSTAR. Is this depicted on the graph at the end of your testimony?
Mr. KNIGHT. Yes. Yes, sir. The two methods of analysis that I discussed earlier, the liquid limit and the shear friction analysis methods, are outlined in very general terms in that approach.
But the Corps' contention is that the wall will move slightly inward and that that earth pressure will be relaxed and lowered. In theory, we agree that that's what will happen. If I can describe that earth pressure, hopefully in terms that laymen can understand, when the soil is placed behind the wall, it is compacted; it's placed in controlled lifts and it is rolled and compressed. That process compresses the soil vertically and horizontally. It compresses it in every direction by the exertion of that force.

The earth pressures we're talking about can be related to the example of a compressed spring. That compressed spring presses on the back of the wall and tends to push it away; in other words, push the wall in. What the Corps' position is: that the wall only needs to move a small amount before that spring is relaxed and that major part of that force is taken away. What our argument is: that we don't know how far that wall has to move before that force is completely removed or is removed enough so that the wall becomes stable. What we do know is that that spring force pushing against that wall caused the walls to crack, and it's the crack we've discussed that was found in 1967.

Further, when we go in and do in place tests of the soil as it exists now, we still find, despite the fact that that wall has moved slightly as a result of that crack, that those high earth pressures are still there. We say that it's indeterminate how much farther the wall has to move before those high earth pressures are relaxed.

The second part of that is, not knowing how far the wall has to move, neither do we know how much movement the wall can tolerate before some part of the system stops to function—how far will the wall move before gates don't close, before valves don't function properly, or before some other part of the system fails to work? Those two indeterminates leave us only with the conclusion that we've got to correct that situation of high earth pressures, and therein is the difference between our opinion and the Corps'. They believe that a small amount of movement is possible without disabling consequences, and we say we don't know how much that movement is and we don't know how much the wall can tolerate. Therefore, we think that the method that we used is appropriate.

Mr. CLINGER. Will the gentleman yield?

Mr. OBERSTAR. Yes. I just wanted to follow up there: how small is small in terms of distance of movement?

Mr. KNIGHT. Well, there is a theoretical approach to calculating how to get from what is called the at-rest earth pressure and the active; in other words, the compressed spring at rest and the active when it has been released. That theoretical approach would indicate that the walls need to move in the range of a half of foot at the top to go completely from at rest to active. In actual practice, that's a very difficult thing to estimate, and it's dependent on the soil characteristics, which as Mr. Hung has pointed out are quite variable, and it in actuality is an indeterminate value, we believe. So we don't know how far you would have to go to get enough relaxation to remove that force.

Mr. OBERSTAR. Thank you.

I yield to the gentleman.

Mr. CLINGER. I thank the chairman for yielding.

Let me just understand: the spring is not getting any more compressed; the pressure is not increasing over time?

Mr. KNIGHT. No, it's not increasing. It has relaxed some. It has to have from its beginning condition as a result of the crack. The wall did, in fact, move, which means that it has released some. What we don't know is where on that curve from full compression to full relaxation we are. What we see happening when the lock is filled and emptied and filled and emptied, the walls do move slightly. The Seaway Corporation, since the crack occurred, has been

taking measurements. So the walls do flex. What we don't know is where on that curve that cycling of relaxation and compression is. It isn't getting worse, but in our opinion it isn't getting better. We don't know how much farther it has to go until it's relieved.

Mr. CLINGER. Mr. Duscha, you say that with the crack that occurred, whenever it did, that basically the spring and the wall are now in equilibrium, and that the risk that anything more extreme is going to occur is relatively slight?

Mr. DUSCHA. Yes, we think the risk has been diminished, and we feel that the state of the backfill is more toward an active state perhaps than——

Mr. CLINGER. I'm sorry, that the what is——

Mr. DUSCHA. It tends to be closer to the active state than the at-rest state that Mr. Knight——

Mr. KNIGHT. But, Mr. Clinger, I would add that we were directed by the Seaway Corporation and the consultant that they had working for them before we came onboard to attempt to measure those earth pressures as they exist. We went about that in a very deliberate manner—in fact, using two alternative approaches to measuring that force as it exists in the field.

We, in fact, found that those earth pressures are very high. They are higher than were anticipated in the original design. They are higher than we expected they were going to be and that the Seaway's previous consultant expected they were going to be. They exist now; they're very real; and they are very high.

Mr. CLINGER. Thank you.

Mr. OBERSTAR. All right.

What can be the consequence of those high earth pressures?

Mr. KNIGHT. Well, sir, we believe that—and that's the essence of the problem, I think—that those high earth pressures make it a very close call whether those walls are stable in the present condition or whether they aren't, and our whole contention is that under that kind of a circumstance we can't take a conservative approach to the situation. A continuation could lead to enough additional movement that some part of that system won't work.

Mr. OBERSTAR. Mr. Duscha, your response or that of any of the engineers to anything that Mr. Knight has said?

Mr. DUSCHA. I think Mr. Knight has said that if further cracking occurs and items of similar nature, then something may have to be done. I couldn't disagree with that. I think we have to keep looking at these structures to see if there are other manifestations that show up in the future that may indicate that there is a stability problem. Today we don't see it.

We haven't seen any cracking. The alignments appear proper. There is no spilling betweem monoliths because of movements that we've noticed, so we come to our conclusion.

Mr. OBERSTAR. The existing crack is not a matter of concern; it's been there for 20 years?

Mr. DUSCHA. I believe the existing crack has been fixed, and I think when Mr. Knight talks about the at-rest pressures or the higher pressures for the wall, that, indeed, that was the better approach. For the structural adequacy of the wall.

Mr. OBERSTAR. Mr. Hung, did you have a——

Mr. HUNG. Yes. I would like to just make a comment on the structural crack in the culverts. Although in 1968 and 1969 we did spend $5.4 million to close that crack, in 1981 when we had Harza engineers, the consulting engineers proceeded Gannett Fleming, when they did the overall engineering survey, they did express a concern because they were worrying about the water—there was still water dripping through. As a matter of fact, at the Snell lock if you go into the south side of the culvert, you'd better have your umbrella with you. It is dripping through quite a bit, and that is our concern too. The post-tension in the anchor they put in almost 20 years ago, it's just not as good as the post-tensioning today. It could be corroded and then we're going to lose that piece of monolith. So it is our concern—if the lock is shut down, it's a shut down—it doesn't matter if the whole structure is sliding or the upper part of it is caving in.

With that in mind also, we had directed Gannett Fleming to make sure those post-tensions they designed would again go through those cracks, and they did that. So I just wanted to make that particular——

Mr. OBERSTAR. Well, that's very important. How much of a job is it to go in and look at that post-tension anchor, the work that was done 20 years ago, and determine whether it is still structurally sound or needs to be replaced? Mr. Duscha?

Mr. DUSCHA. Well, I imagine we could inspect to see if there's any opening. That wouldn't be a big job. If you had to perhaps dig into it to see how the anchor was holding, that would be something else. I really don't know because I don't know the anchoring system.

Mr. OBERSTAR. Mr. Hung, how much—do you have any cost estimates of what it would take to get in there?

Mr. HUNG. No, sir, I don't.

Mr. OBERSTAR. Mr. Duscha, when the Corps team went up to the site on August 21, did they follow the stages or phases of investigation listed in the ETL? Were those steps followed?

Mr. DUSCHA. Do you mean in Phase I?

Mr. OBERSTAR. Yes. Well, in full or in part, or what was done?

Mr. DUSCHA. No, they did not do this at the site, sir.

Mr. OBERSTAR. So they did not follow those steps?

Mr. DUSCHA. This type of analysis was not done at the site. They looked at the structures and the analysis beforehand.

Mr. OBERSTAR. Well, I thought that's what the guidance is for. How long a time does it take to do the kind of analysis that is spelled out in the ETL? Is that more than a day's work?

Mr. DUSCHA. I would guess it is. It's certainly more than a day, but what we have to remember here is the background work was done by Gannett Fleming for much of this, so we're using their background data.

Mr. OBERSTAR. Well, you're using that background data, but applying it in a different way than they have in the past and not following the procedure the district engineer would do if he were to go up there. Well, it strikes me—there is a whole basketful of questions I could further ask.

It seems to me that really the way we're going to get at the bottom of this is to—we have different viewpoints. The Corps is

now launched into a new frontier really, a new era, of evaluation of structures; right? You're applying 1.6 now to all of the inland waterway structures instead of 2.0 as in the past, and you've got your fingers crossed a little bit and you've got them placed on your computer and on your analyses and on the heads of all the engineers who've looked at this. You're hoping that it's all right.

The only way you're really going to know is another 20 years of experience—if nothing falls in, I guess you were right. If it does, you were wrong.

If something happened—maybe something happens even if you apply the old criteria, but if you do apply the old criteria, it says to you and your best engineering judgment, as you've always done in the Corps, get in there and do something now, preventive action, so that the worst scenario doesn't occur.

Maybe what we have to have here is the district engineer to come up and take the ETL and go through it step by step and develop all these numbers over again.

I see one of your engineers shaking his head. You're sworn in; you can answer for yourself. Yes or no?

Mr. DAVIDSON. I think——

Mr. OBERSTAR. Take a microphone, please, and identify yourself.

Mr. DAVIDSON. Well, first of all, a lot of the steps——

Mr. OBERSTAR. Your name is——

Mr. DAVIDSON. Richard Davidson.

Mr. OBERSTAR. Yes.

Mr. DAVIDSON. The steps that were discussed in that ETL are for the whole evaluation. A lot of this work has already been done. I don't think there would be any point in repeating much of the good work that Gannett Fleming has already done. I think the issues and the differences in the analysis are reasonably clear at this point. I don't think a lot more analyses need to be done. More analyses are not going to resolve this issue. It's not a question of doing more calculations. It's a question of basic engineering philosophy and the basic assumptions that go into the analyses.

Mr. OBERSTAR. You don't disagree with Gannett's findings of high earth pressures?

Mr. DAVIDSON. No. Certainly when we reviewed the report, we were as surprised as they were that they got earth pressures that high. Our initial reaction was skepticism, but I think we became convinced that they probably are real.

Mr. OBERSTAR. Our only difference is what do these higher pressures mean?

Mr. DAVIDSON. Yes.

Mr. OBERSTAR. Gannett and the Seaway Authority feel they mean problems and you feel it means that the original work was so well done and so structurally sound that they don't mean what they used to mean?

Mr. DUSCHA. Well, we feel basically that we do not have the stability problem today. I think it's more than hope. I would not be sitting here making this decision on hope that it works out. I think we have a degree of confidence that the reduced factor of safety is legitimate and logical.

Mr. OBERSTAR. The reason for this hearing, as Mr. Clinger pointed out and as I said in my opening remarks, is that because this

change in criteria ushers in a new era, it's important for us to take a look at it now, think it through carefully. It raises eyebrows when the Corps, of all agencies, moves from a conservative engineering judgment to something less than that judgment.

Those of us who represent districts on the Great Lakes—that's New York, Ohio, Illinois, Indiana, Wisconsin, Minnesota, Pennsylvania—have an economic stake in that Seaway, a very important one. It represents about 2,000 jobs in the city of Duluth, plus or minus, depending on the economic swings. If that Seaway shuts down, an awful lot of people shut down their livelihoods.

It would trouble me greatly if someone were to say, "Way back there, remember, when the Corps was changing these criteria you didn't make them think it through hard enough. For $18 million you could have saved a half a billion of economic loss to the country."

On the other hand, we're going to be dealing this afternoon, somewhere around seven or eight o'clock tonight, with the final vote on passage of a continuing resolution dealing with the budget and the deficit for the next Fiscal Year. Eighteen million dollars here and $18 million there, pretty soon it adds up to real money, to quote Everett Dirksen, only he was saying a billion here and a billion there adds up to real money. We're dealing with a little lesser numbers that everyday folk can understand. We don't want to direct on a wholesale basis overly cautious action that results in costs that could otherwise be avoided.

But since this is a matter here that still is guidance and leaves a great deal to the judgment of the individual engineer, and on which there is a reasonable difference of opinion, it just strikes me that we ought to have a further review, and certainly no less than a look at that lock when it's dewatered by the Seaway and its experts and the Corps with its experts. We ought to informally review that finding. We can reconsider, revaluate before we consider the FY 1989 appropriations and include whatever funds may be necessary there.

But I am haunted, I must tell you, by the 1985 report that said you've got to move, you've got to get this thing going in the winter of 1986–87 and continue it in 1987–88 because something may happen. Now a change in criteria has said fall back, it's not that urgent; it isn't that important.

Do I overstate or understate or misstate the proposition?

Mr. DUSCHA. No. The Corps of Engineers certainly can appreciate your concern between the 1985 report and what we're telling you here today. There's an understanding of why you feel this way.

We certainly feel that the committee has a right to legitimately question these changes in criteria, as we feel the St. Lawrence Seaway Development Corporation has a right to question the revised criteria. By this type of questioning we all become a little bit smarter in this process, and it's for the good of all. We do welcome this type of questioning, and we certainly intend to keep looking at these issues to prove that we are right, and to reinforce our position. We certainly look to the opportunity of visiting that particular site when it's dewatered because I think that is very important. I have no problems at all, sir, with what you are suggesting.

Mr. OBERSTAR. Mr. Hung, do you have any further comments?

Mr. HUNG. Yes, thank you, Mr. Chairman.

I just wanted to add, as far as the site visit, the Buffalo Corps engineer has always been invited to visit Eisenhower and Snell locks every winter. They have been doing the inspection with us every year. I just want that to be on the record. As far as the gentlemen from Washington, D.C., they are definitely welcome.

Mr. OBERSTAR. Thank you.

Mr. Knight?

Mr. KNIGHT. Mr. Chairman, just two very brief points: you asked a few moments ago about the ability to go in and re-examine those post-tension anchors that were installed in 1968–69. Our understanding of that anchorage system is that it is not now in a position where you can re-evaluate it in normal methods. There are a couple of alternatives in installing anchors. They could have been left with the heads exposed so that liftoff tests could be done. We believe that's not now the case. Those are sealed. They were encased in concrete and were stressed their entire length and locked off there. Once in place in that kind of a condition, we don't know of any practical way to re-evaluate them.

The other factor is that Mr. Duscha has stated with great sincerity that they have some confidence in what they're now stating, and our problem is that we have some doubt. Under circumstance of doubt, we're left with little alternative but to recommend that some remedial actions take place.

Mr. OBERSTAR. We still share the doubt or the skepticism, I will put it at this point. The experience of this subcommittee is that it is better, if we err, to err on the side of safety than on the other side.

When the airline operators came to the Federal Aviation Administration and said, "It is perfectly safe to remove the wing exits from 747 aircraft and allow us to carry a little more fuel and maybe a few more passengers; it will be perfectly safe," and the Boeing company agreed with that judgment, we had testimony at hearings that showed the only people who survived on the Tenerife accident, which was civil aviation's worst, were the 60 people who got out through the over-the-wing exit; that the people who were evacuated the quickest and the safest in the crash of the 747 in Pakistan were those who got out over the wings. Those who escaped in other accidents were the ones who got out over the wings.

As a result of hearings conducted in this room, the FAA issued an order that no over-the-wing exits were to be removed from 747's. We'll never know whether people's lives are saved because those exits are there until a crash occurs, and we hope one never occurs, but we feel better, I think, having erred on the side of safety.

There may not be lives at stake if one of the monoliths cuts loose from the Eisenhower or Snell locks, but there are economies at stake and the livelihoods of people, and hopes that may be dashed, problems that may be irretrievable, and so I think it behooves us to step very cautiously as we move forward on this matter, and we shall revisit it.

Does the gentleman from Pennsylvania have any closing comments?

Mr. CLINGER. I think you've said it all, Mr. Chairman. Thank you for holding the hearing.

Mr. OBERSTAR. Thank you very much, gentlemen. We greatly appreciate the time, effort, and trouble you've taken and your very thoughtful and thorough responses.

We will have further questions for the record.

[Whereupon, at 2:18 p.m., the subcommittee recessed, to reconvene at the call of the Chair.]

[The prepared statements of Mr. Doyle, Mr. Emery, and Mr. Knight plus responses to supplemental questions follow:]

Statement by

John S. Doyle, Jr., Acting Assistant Secretary of the Army

(Civil Works)

Before the Subcommittee on Investigations and Oversight

Committee on Public Works and Transportation

House of Representatives

Mr. Chairman and Members of the Subcommittee

I am pleased to appear before you today as Acting Assistant Secretary of the Army (Civil Works). Since I may have to leave before you adjourn today, I asked my Deputy for Program Planning, Review, and Evaluation, Dr. G. Edward Dickey, to accompany me. In addition, accompanying me here from the Office of the Chief of Engineers is Mr. Lloyd Duscha, Deputy Director of the Engineering and Construction Directorate, Mr. Robert Smith, Chief of the Structures Branch, Mr. Richard Davidson, Chief of the Soils Mechanics Section, and Mr. Jesse Pfeiffer, Research Coordinator.

We are here today, because the position of the Corps regarding the Eisenhower and Snell Locks' stability is not in agreement with the recommendations contained in the Gannett Fleming report. The Corps and Gannett Fleming agree on the physical condition of the locks and the physical properties used in the engineering analyses of the locks. I am not aware of any disagreement over the need to

repair deteriorated concrete at the locks. The only disagreement is over the need to stabilize the locks. As I understand it, the Corps and Gannett Fleming are using different engineering analyses to evaluate the lock's stability.

I will summarize briefly the results of Army Corps of Engineers technical evaluations of the proposed rehabilitation of the Eisenhower and Snell Locks. The most recent work was done as part of discussions between the Departments of Transportation and Army following our joint testimony before you on July 15 of this year. The Corps reviewed Gannett Fleming Geotechnical Engineers report and evaluated the stability of the locks using newly available research results on the stability of existing concrete navigation structures. Messrs. Smith and Davidson visited the site on August 21.

As noted by my Deputy, Dr. Dickey, at the July 15 hearing, the Corps designed and constructed the Eisenhower and Snell Locks under an agreement with the St. Lawrence Seaway Development Corporation. The Corps has continued to provide technical assistance to the Corporation at its request always on a reimbursable basis.

There is a history of concrete problems at Eisenhower Lock. In addition, both locks have had problems with cracks in the conduits that are used to fill and empty the locks. The

Reconnaissance Report prepared by the Buffalo District in 1984 recommended the repair of deteriorated concrete, lock wall stabilization, and other minor repairs.

As noted in our September 28 letter to you concerning cost differences of the rehabilitation proposals which accompanies my statement, our review of the Buffalo District and Gannett Fleming reports found that the scope of the work recommended in the two reports differed significantly. The District recommended both concrete and stability work. The Gannett Fleming report only addresses the stability of the locks. Furthermore, Gannett Fleming developed a more cost-effective design for lock wall stabilization.

I should note that the intent of the District report was to present a conservative cost estimate for preliminary budget purposes. It used the best available criteria to evaluate the stability of the locks and proposed reasonable remedial measures. A more detailed study, including an evaluation of alternative designs, was not performed by the District because of funding constraints. In 1985 the Office of the Chief of Engineers informally reviewed the report and noted that the proposed work appeared to be justified and was similar in nature and scope to work that had been performed at Corps locks and dams under the Major Rehabilitation Program. Within the Corps of Engineers, approval of this report would have constituted permission to

proceed with more detailed studies to justify each proposed work item and investigate alternative solutions. It is not unusual for such studies to substantially change the scope of the work initially proposed.

At about the same time the District was completing its report, the Corps was initiating the Repair, Evaluation, Maintenance and Rehabilitation (REMR) Research Program. This is a $35 million program to identify and develop effective and affordable technology for maintaining and extending the service life of existing water resources projects. It was established, because the number of Corps locks that have exceeded their design life has been increasing dramatically. By the year 2000, 40 percent of Corps projects will be more than 50 years old.

In 1985 the Corps initiated a study under the REMR program to evaluate the accuracy and reliability of conventional stability analysis methods. Based on this recent analysis, it is now the position of the experts in the Corps that the Eisenhower and Snell Locks will not topple over or slide shut. Therefore, the proposed remedial measures for stablizing the lockwalls are not needed.

As detailed in my September 30, 1987, letter to the Secretary of Transportation, which I am submitting for the record, the stability of the lock walls is satisfactory when evaluated against newly developed Corps stability criteria for existing concrete

navigation structures on rock foundations. The Corps believes that the stability analysis method it has traditionally used is unnecessarily conservative, because the analysis ignores the important vertical shear loads on the back of the wall. It also believes that the use of at-rest earth pressures, as currently being used for stability analysis, is too conservative for dense backfill materials, such as those found at Eisenhower and Snell Locks.

Another factor to be considered is that the locks have been dewatered many times during their service life without stability problems. The Saint Lawrence Seaway Development Corporation has taken parapet-to-parapet measurements for the lock chamber widths at various times for the last 20 years at both the Eisenhower and Snell Locks. These measurements indicate that the chamber widths fluctuate normally in response to the water level in the chamber and show no indication of any stability problems.

The new stability criteria are being used by the Corps to evaluate potential stability problems for its own locks. If stability work was recommended previously but construction has not started, the proposal will be reviewed using the new criteria based on the REMR research. We expect that remedial measures for stability purposes will be recommended less frequently resulting in a considerable reduction in future major rehabilitation expenditures at Corps projects.

I must acknowledge that the Corps judgments regarding the Eisenhower and Snell Locks are based, in part, on the results of an ongoing research program. I also should note that the evaluation was limited only to the sliding and overturning stability of these locks. Whether there may be other problems involving severe concrete deterioration at the concrete-rock interface, major structural cracks, or the existence of weak seams or other foundation deficiencies which could affect the stability of the locks was not evaluated. The Corps is aware of one potential foundation problem that could affect the Snell Lock. Drilling for instruments for the REMR research program at the lock indicated holes in the limestone bedrock underneath the lock. This information has been furnished to the Seaway Corporation engineering staff.

In closing, Mr. Chairman, I would like to reiterate our Department's testimony at the July 15 hearing. The Army Corps of Engineers has the capability and willingness to continue to work with the Seaway Corporation to study and repair the structures on a reimbursable basis. This is consistent with the Administration's proposed legislation that would return the toll revenues to the Corporation, thereby restoring toll-based financing for ongoing costs of operating, maintaining, and repairing navigation features of the Saint Lawrence Seaway.

Mr. Chairman, that concludes my presentation. Thank you for this opportunity.

RESPONSE FROM CORPS OF ENGINEERS

QUESTION:

What other agencies, if any, are using the revised stability criteria for concrete structures which the Corps is now using?

ANSWER:

We are not aware of any other agencies using the revised criteria. Typically in the past, when Corps criteria are published, the guidelines are sought by other agencies if they have a need and they then determine if the criteria are applicable for their needs. Since the Corps is regarded as the agency with expertise in lock design, it is anticipated that if other agencies investigate the stability of existing lock walls the criteria would be used.

RESPONSE FROM CORPS OF ENGINEERS

QUESTION:

Assistant Secretary Doyle, in his September 30, 1987 letter to Transportation Secretary Dole stated that "no remedial measures for stabilizing the lock walls are needed at this time." Yet the letter, and his statement before the subcommittee, carefully address sliding and overturning problems only. The statement raises other possible problems, including concrete deterioration, major structural cracks, weak seams and other foundation deficiencies. Additionally, the Corps found voids underlying the foundation of the Snell lock, discovered when the Corps was drilling for soil samples. Further problems may be discovered when the locks are dewatered in January, 1988. What is the Corps' position on the need for additional work to investigate or remedy stability problems other than overturning and sliding?

ANSWER:

The Corps considers additional investigations on the adequacy of the structural repairs done in 1967-68 warranted. This work consisted of repairing the cracks from the filling and emptying culverts to the back of the walls. We understand the Gannett Fleming firm has performed a finite element analysis of the walls to determine the adequacy of the repairs but the Corps has not reviewed the work. Also, the Corps believes a foundation investigation to determine the extent and magnitude of the voids in the foundation should be performed. It could then be determined if a foundation grouting program is called for to assure adequate bearing capacity of the foundation to support the lock walls.

RESPONSE FROM CORPS OF ENGINEERS

QUESTION:

Mr. Knight of Gannett Fleming Geotechnical Engineers testified that other problems could result from movement due to high earth pressures, including inoperability of miter gates, inoperability of valves, and misalignment of walls. These potential problems would have been averted by the rehabilitation work proposed by the Seaway Development Corporation. Why did the Corps not include these potential problems in its stability study?

ANSWER:

The Corps did include in its stability study such items as proper miter gate operation, proper valve operation, and misalignment of the lockwalls. The history of Eisenhower and Snell locks has been satisfactory, i.e., the movement of the lockwalls has been small and has not caused any operational or maintenance problems and the mechanical items have operated satisfactorily. In fact, the Seaway Development Corporation has been doing an excellent job of operating and maintaining the locks and there is no reason to believe that it will not continue in that fashion. Based on the information we have been provided, we consider the structures to be stable with little potential for significant movement of the lockwalls and we believe the locks will continue to be operationally adequate.

RESPONSE FROM CORPS OF ENGINEERS

QUESTION:

The Engineer Technical Letter No. 1110-2-xxxx, Page 1, states that "It may not be necessary to improve the structure's stability to satisfy the referenced criteria when the remaining life of the structure is relatively short or when there are no indications of any stability problem. [Emphasis added.] Given the prior history of structural cracking and subsequent repair of the Seaway locks, and the relatively long remaining life of these structures, why did the Corps not take these factors into account when reevaluating the structural stability of the locks? Why did the Corps apply the relaxed criteria to these structures?

ANSWER:

The Corps did take into account the remaining life and looked for indications of instability when they reviewed the Gannett Fleming design for additional stabilizing measures. There is no indication of any stability problems at either lock after some 30 years of operation. The topography and the type of backfill materials are such that the high measured backfill pressures will not increase with time, therefore the structures have already experienced the most severe static loading conditions. With the Seaway Corporation's excellent maintenance program and possible future structural and foundation investigations, the Corps feels confident in applying its new criteria to these two existing structures.

RESPONSE FROM CORPS OF ENGINEERS

QUESTION:

The Seaway Development Corporation's request to the Office of Management and Budget included step removal and replacement, and sill and sloped face concrete removal and replacement. Should the Corporation's request be dropped from the budget based on the Corps' stability analysis of overturning and sliding only, what would be the consequences for continued safe operation of the locks?

ANSWER:

The Corps is not in a position to comment on this matter. The Corps reviewed the Gannett Fleming design for additional stabilizing measures of the lock walls. This design was based on the assumption that the walls act monolithically. We cannot take a position on the concrete condition, since we have not investigated that aspect of the locks. We defer to the Seaway Corporation investigations of this area.

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RESPONSE FROM CORPS OF ENGINEERS

QUESTION:

Mr. Duscha stated that locks 2, 3, 5, 7, 9 and 12 on the Mississippi River were analyzed according to a 1984 Engineering Technical Letter. What is the factor-of-safety for each lock? What Corps structures have been or will be analyzed under the undated 1987 draft Engineering Technical Letter No. 1110-2? What is the factor-of-safety assigned to each such structure already analyzed? What structures will be evaluated under this ETL once it is finalized?

ANSWER:

In January 1987 several lock and dam projects on the Mississippi River were investigated using the draft Engineering Technical Letter (ETL) that was developed in 1984. In all cases, the safety factors exceeded the draft ETL requirements with a factor of safety against sliding for each larger than 2.0. In addition, locks 20 and 22 were also evaluated. Both of these structures met the draft ETL criteria for sliding and overturning, however, the locks failed to meet the more stringent existing criteria for new locks. Since the draft ETL criteria was met, no remedial measures were taken. The undated 1987 draft ETL uses the same principles of analyses as the 1984 draft ETL, and it also has incorporated the most recent REMR research findings. Currently, Demopolis lock is being evaluated using the 1987 draft ETL. In the near future locks and dams 14 and 15 will be evaluated using the new criteria as will all existing Corps locks requiring a reevaluation.

RESPONSE FROM CORPS OF ENGINEERS

QUESTION:

At whose request, and under what authority, did the Corps of Engineers reevaluate the need to stabilize locks owned and operated by the St. Lawrence Seaway Development Corporation? Had the Corps called to the Subcommittee's attention its new analytical procedures, when the agency testified at our July 15 hearing, the Subcommittee might have requested such an analysis. Not being acquainted with the work being conducted under the Repair, Evaluation, Maintenance, and Rehabilitation program, the Subcommittee at that hearing simply requested a comparison of the Buffalo District's and GFGE's proposals.

ANSWER:

The subcommittee directed DOT and the Corps to rectify the cost differences between the Buffalo District report and the Gannett Fleming design. While reviewing the Gannett Fleming reports, it was noted by the Corps that if the locks were evaluated using its new criteria, which included the recent REMR research findings, the lock walls were stable. This information was forwarded to the ASA(CW), DOT, the Seaway Corporation and the Subcommittee staffs.

Testimony by James L. Emery, Administrator
Saint Lawrence Seaway Development Corporation
Before the Investigations and Oversight Subcommittee
Public Works and Transportation Committee
December 3, 1987 - 9:30 a.m.

Background

Soon after my appointment as Administrator of the Saint Lawrence Seaway Development Corporation in November of 1983, I began a thorough review of the Corporation's physical assets and management to assess what changes, if any, might be needed to insure the safe efficient transit of vessels through the Seaway.

There appeared to be two problems with the structural integrity of the locks. First, the longstanding problem of deteriorating concrete at Eisenhower Lock which was detected even before the locks opened in 1959. The problem was linked to the use of natural cement and the length of curing time before the freeze. Between 1959 and 1983, the Corporation spent $9.7 million to remedy this problem. Moreover, because of the poor concrete the Corporation was covering and heating Eisenhower Lock every winter at a cost of $250,000.

The other problem with the locks was their structural stability. In 1967, cracks in the culverts were discovered at both Eisenhower and Snell Locks. In 1968 and 1969, $5.4 million was expended for post tensioning to remedy the problems at Eisenhower and Snell Locks. The Corps of Engineers Board of Consultants after reviewing the work done to correct the culvert cracks felt the necessary repairs had been completed satisfactorily.

Harza Engineering Study

In 1980, the Corporation hired Harza Engineering Company of Chicago, Illinois to prepare an engineering survey report on Eisenhower and Snell Locks. The final report issued in January of 1981 included both concrete and structural investigations. The major findings were as follows:

Concrete - No problem was found at Snell. Deteriorating concrete at Eisenhower was found to still be a significant problem though the SLSDC maintenance program was on top of the problem and keeping ahead of the deterioration. They recommended continued concrete resurfacing to correct the problem. The estimated cost was $3,750,000.

Structural - Using the high observed water levels and the same earth pressure assumptions used by the original designers, Harza found that the overturning stability of the locks was unacceptable. Furthermore, the culvert cracks were not in compression according to their computations, and the sliding stability of the walls was unsatisfactory with respect to modern criteria. An extensive

rehabilitation program would be required to close the culvert cracks and improve the sliding stability to minimum modern requirements. The report indicated required repairs would consist of an anchoring system with a cost estimate of $6.5 million at Eisenhower and Snell Locks. This work, however, was not recommended at the time because of the poorly known properties of the backfill which were used to compute earth pressure. A program of additional soils exploration and testing was recommended to collect soils samples, determine more accurate soil properties for use in stability computations, and confirm water levels in the backfill. The walls would then be reanalyzed when soil test data from the exploration program was available.

In 1981 the Corporation contracted with Empire Soils Corporation to conduct limited soil tests. The result of these tests substantiated the findings of the Harza Investigation.

Corps of Engineers (Buffalo District) Report

Background - On June 27, 1984, personnel from the Corps of Engineers District office met with SLSDC engineers in Massena, New York and were briefed on concrete deterioration and lock wall stability problems. The Corporation prepared a report on remaining extraordinary repairs required to the locks and this report along with other technical data was delivered to the Corps on August 30, 1984. The Corporation then entered into an agreement with the Buffalo District to prepare a Reconnaissance Report on Major Rehabilitation at Eisenhower and Snell Locks.

The COE Distrtict Report - In February of 1985, the Corps Buffalo District issued their Reconnaissance Report to the Corporation. The Report recommended major rehabilitation was required and estimated a total cost of $39 million for concrete deterioration repair, lock wall stabilizations and other minor repairs at October 1984 price levels.

The report noted that "Because of the urgency of repairs, the work is scheduled to be initiated in the winter of 1985-86". The Report reached its recommendations assuming the following:

The Corporation obtains the necessary appropriation.

The Corporation agree that the Corps design, construct and supervise the work.

The Corporation fund and accomplish concrete resurfacing work in the winter of 1985-86.

Detailed design of post tensioned anchoring take place during FY 1986 followed by construction during subsequent winter maintenance periods.

Economic Impact

It should be noted the Corps Recon Report indicated a closure of the locks could result in serious economic impact to Great Lakes shipping and regional and port employment. The economic cost of shipping commodities via other transportation modes would be $200 million. The report states there would be an additional impact to Great Lakes region and port employment which would impact almost 12,000 jobs with a dollar impact of $338 million. In summary, a closure of the locks could cost the System over one half billion dollars ($200 + 338 = $538 million).

This issue of course became more important as a result of the Valleyfield incident which closed the Seaway in November of 1984 for 19 days. Subsequently in October of 1985 the blowout of Lock 7 at the Welland Canal again closed the system for 24 days. Lawsuits totalling $50 million have been filed against the St. Lawrence Seaway Authority by shipping companies alleging economic losses.

Corporation Response

Concrete Work - As I have indicated, the issue of concrete deterioration at Eisenhower Lock is separate from and has little bearing on lock stability which is subject to external forces. Rather than continue the piecemeal approach of concrete repair, the Corporation decided to complete this work in a two year period. In the winter of 1985-86, $2.1 million of concrete repair financed from the Corporation's financial reserve was accomplished. In the winter of 1986-87, concrete repairs funded by a $2 million appropriation from Congress were completed. The massive two year effort has remedied the deteriorated concrete on the lock walls at Eisenhower Lock and the Corporation no longer needs to annually expend $250,000 to cover and heat the lock. In conclusion, the deteriorated concrete on the lock walls has been remedied.

Lock Wall Stability

Clarkson Professor Reviews Stability

In January of 1986, the Corporation retained Professor Alan Lutenegger of Clarkson University to review all pertinent data (Corporation data, Harza Report, Corps Report) to reconfirm whether a detailed engineering study was required and, if required, to prepare the work statements for A/E services. Professor Lutenegger filed a report with the Corporation indicating there are lock wall stability problems at both locks and the Corporation should seek bids to perform detailed engineering and design for the remedial work.

Corporation Retains Consultant For Detailed Study

In May of 1986, the Corporation awarded a contract to Gannett-Fleming Geotechnical Engineers of Harrisburg, Pennsylvania

to prepare a report on the extent of the problem and alternate means of accomplishing the work.

Gannett-Fleming Preliminary Report

Gannett-Fleming spent all summer at Massena, New York conducting various soil and water level tests and analyzing data. In October of 1986, they issued a preliminary report which indicated there was indeed a stability problem and recommended the most cost-effective approach - concrete struts and post tensioned anchors - be pursued to increase the factor of safety at the locks.

Final Report/Eisenhower Lock

During the winter shutdown and with Eisenhower Lock completely dewatered, Gannett-Fleming collected additional concrete, rock and water level data and completed its analysis of data at Eisenhower Lock. In May of 1987, final plans, specifications and a cost estimate of $7.5 million to improve the lock wall stability at Eisenhower was submitted to the Corporation. It should be noted the work at Eisenhower included the replacement of deteriorated concrete steps required to insure the struts could adequately be placed.

Final design of Snell will be completed in the winter of 1988 when that lock is completely dewatered and surveyed. Gannett-Fleming estimated the cost to rehab Snell would range from $6.5 million to $9.5 million. Thus the estimated cost to rehab both locks was estimated to be $18 million at the high range which includes construction management costs.

It should be noted the Corporation provided Great Lakes Congressmen, Appropriation Committees, OST and OMB with the Gannett-Fleming reports. Moreover in October of 1986, both the North Central Division and the Buffalo District of the Corps of Engineers were briefed on the preliminary Gannett-Fleming Report by Corporation engineers. In addition, the final report on Eisenhower was delivered to the Buffalo District soon after it was issued.

Funding the Rehab

Public Law 99-662, the Water Resources Development Act of 1986 (Section 1163) authorized up to $39 million for stability improvements.

"SEC.1163 EISENHOWER AND SNELL LOCKS

Subject to section 903(b) of this Act, the Secretary is authorized to rehabilitate the Eisenhower and Snell Locks, Saint Lawrence River, Massena, New York, in accordance with the report of the District Engineer, dated November 1984, at a total cost of $39,200,000. The Federal share of such project shall be 100 percent, from the general fund of the Treasury, except that up to 25 percent of the cost of such project may be paid from tolls collected on the Saint Lawrence Seaway to the extent that the

rehabilitation is not attributable to decisions and recommendations of the Corps of Engineers."

As you know, Mr. Chairman, you and 26 other Congressmen requested the Senate to fund the Eisenhower rehab in FY 1988. It should be noted the Corporation did request bids on Eisenhower in October of 1987 in the event Congress provided the funding. The bids ranged from $8.7 million to $12 million. (The reason for higher bids is probably due to a massive $500 million project at Fort Drum located 90 miles from Massena).

Congressional Hearings on Lock Rehab

Mr. Chairman. On July 15, 1987, your Subcommittee held a hearing on the status of rehabilitation of the Seaway locks. One issue not resolved at the hearing was the resolution of the estimated cost to do the rehab as recommended by the Corps vis a vis estimated costs estimated by the Corporation's engineering consultant, Gannett-Fleming. As a result, you directed DOT and Corps to resolve these differences and report back to the Subcommittee in 60 days.

Corps Indicates No Stability Problem

On August 13, 1987, several Corps officials met with Seaway Congressional liaison and DOT policy staff to discuss their current position on the major rehabilitation of Seaway Locks. Contrary to their own Reconnaissance Report prepared in 1985 and their Feasibility Report for St. Lawrence Seaway Additional Locks Study completed in January 1987, which discussed the stability problem and recommended the Corporation expeditiously carry out the major rehab work to insure the structural integrity of the locks, the Corps now concludes there is no stability problem at the Eisenhower and Snell Locks. This conclusion is primarily based on newly proposed, less conservative criteria which permit the use of shear loads behind the wall and active earth pressure for dense backfill materials.

On August 21, 1987, five Corps officials made a one day on site visit to the locks in Massena, New York for a visual inspection. They were accompanied during their visit by the Corporation's Chief of Engineering and Planning, Steve Hung.

Meeting To Discuss Revised Corps Criteria

On September 9, 1987, a meeting was held in Washington, D.C. to discuss the new Corps position.

Attending the meeting were officials from the Corps, DOT, SLSDC, Gannett-Fleming, Professor John Schmertmann of Florida University, Gannett-Fleming's Consultant, and Professor Al Lutenegger of Clarkson University, a SLSDC Consultant. The result of the meeting was that the Corps and the SLSDC's consultants disagreed on the need for rehabilitation.

The key issue is the Corps' revised criteria which has not been utilized for evaluation of any Corps structures. Mr. Hung, my Chief Engineer, and Mr. Knight, President of Gannett-Fleming, will amplify on this point. Moreover, with the risk of substantial economic impact to Great Lakes shipping and ports, a more conservative safety criteria may be prudent.

Corps Response to Secretary Dole

On September 30, 1987, Acting Assistant Secretary of the Army (Civil Works) John Doyle, Jr. wrote Secretary Dole and indicated that based on the Army Corps of Engineers technical evaluation it was the position of the experts in the Corps that both Eisenhower and Snell Locks are stable against overturning and sliding and therefore no remedial measures for stabilizing the lock walls are needed at this time.

The bottom line is the Government's experts in designing and building locks state there is no immediate problem.

Mr. Chairman. As I said at the beginning of my testimony, the physical dependability of the locks has been a top priority. In addition to addressing the major rehab items of concrete deterioration and lock stability, the Corporation in 1984 put in place a 5 year rolling capital plan and beefed up maintenance program.

Capital Plan

Prior to FY 1984, the Corporation had not prepared a comprehensive capital improvement plan in a rational framework. In March 1984, the Office of Engineering and Planning was tasked by me to develop the Corporation's first comprehensive Five-Year Capital Plan. The first plan for FY 1984-1988 was submitted to and approved by me in April 1984. Since then, the five-year Capital Plan has been updated annually. The Capital Plan is intended to be a "living document" to assist management in the budget process and to provide guidelines in scheduling capital improvement projects for Engineering and Maintenance personnel.

The total capital outlay expenditure since 1984 is $4.8 million. The major projects are as follows:

1. Vessel Traffic Control (VTC) Center modernization: Contracted a study to improve lock operations, line handling and VTC Operations which led to the installation of computerized and telecommunication equipment as well as closed circuit television and the video transmission link between the two locks. A water level recorder to provide real-time water level information along the River for VTC was also installed. The total project cost to date is $400,000.

2. Replace/Improve Lock Facilities: This project included the replacement of deteriorated hatch covers, the modifications of valve guides, the overhaul of the brakes and gear drives and the upgrade of

electrical lock control equipment. The total project cost to date is $650,000.

3. Improve guidewall extension at both locks at a cost of $300,000.

4. Improve fendering system at a cost of $300,000.

5. Building rehabilitation/improvements at a cost of $550,000.

6. Navigation aids improvements at a cost of $150,000.

7. Replacement of capital equipment at a cost of $1,000,000 including two hopper barges acquired from MARAD at below market prices. In addition, the Corporation has acquired a surplus buoy barge for its navigation aid operations which would have otherwise required a $500,000 outlay of Corporation funds.

Seaway Contingency Plan

For the first time ever, the Saint Lawrence Seaway Development Corporation has in hand a comprehensive contingency plan which provides for the timely and efficient correction of various hypothetical mishaps that could potentially disrupt the operations of the U.S. Seaway lock facilities at Massena, New York.

As a result of two consecutive major mishaps occurring in the Canadian Seaway section, namely; Valleyfield Bridge incident in 1984 and Welland Lock 7 collapse in 1985, the Corporation in 1986 retained Calocerinos and Spina, consulting engineers in Syracuse, New York to inspect the lock facilities at both U.S. Locks and to prepare a Seaway Contingency Plan. The plan was completed in May 1987. Three hypothetical scenarios, namely; damaged downstream miter gate at either lock, ruptured tunnel roof at Eisenhower Lock and monolith failure at either lock, were addressed.

The plan is particularly valuable because it identifies the types of special internal and external manpower skills that might be required under different circumstances, as well as special equipment available for rapid deployment from within a 200-mile radius of Massena. These factors are of critical importance due to Massena's remote location. Included in the plan are: necessary immediate actions, notification of key personnel, the critical path for making temporary repairs, and the rapid mobilization of equipment and manpower.

Maintenance Program

Since 1984, the Corporation has initiated a beefed up maintenance program which includes the completion of concrete repair of lock walls at Eisenhower Lock, and the initiation of a comprehensive computerized preventative maintenance program.

Planned Maintenance and Capital Expenditures

The Corporation is planning to spend approximately $20 million in the next five years (FY 1988-1992) to carry out the capital improvement and maintenance programs. The current 5-year Capital Plan projects expenditures of $12.5 million.

Major projects include:

Electrical Improvements	$700,000
Navigation Aids	400,000
Extend Docking Facilities at the Marine Base	600,000
Repower Tug	500,000
VTC Computerized Vessel Status System	500,000
Miter Gate Jacking Device	200,000
New Heavy Crane	400,000
Dredging Near Approach Channels at Both Locks	6,500,000

Our FY 87 expenditures of $7.8 million were $500,000 less than incurred in FY 1983. The maximum use of Corporate cash, coupled with several management improvements I initiated, have resulted in recurring savings of $1.5 million which has enabled the Corporation to maintain an invested Financial Reserve of $10 million to deal with unanticipated events which might interrupt shipping on the Seaway.

As previously noted, through the efforts of our employees and managers during the last four years, almost $5 million was expended for plant and equipment and $2 million was expended for extraordinary concrete repairs.

Finally we have a Financial Reserve fully invested as of October 1, 1987 equal to total cash on hand on September 30, 1983. The beefed up Capital Program as well as concrete repair in 1986 were accomplished at the same time tolls were frozen at 1983 levels for 5 years.

Canadian Rehabilitation

Mr. Chairman. I might add also that the Canadian Government has embarked on a $175,000,000, seven year program to rehabilitate and improve the Welland Canal. It should be noted that these funds are a

direct appropriation to the Saint Lawrence Seaway Authority and will not be recouped through the toll structure.

Finally, Mr. Chairman although this hearing does not address the issue of toll retention, it should be noted had the Corporation continued to have access to tolls, it could have financed the rehabilitation of Eisenhower Lock from its financial reserves and remaining bonding authority and still retained a sufficient reserve to meet continued unanticipated events.

Steve Hung, the Corporation's Chief of Engineering and Planning and Jim Knight, President of Gannett-Fleming are here to respond to any technical questions you may have.

RESPONSES FROM ST. LAWRENCE SEAWAY DEVELOPMENT CORPORATION

ANSWERS TO OBERSTAR'S QUESTIONS
DECEMBER 3, 1987 HEARING

1. Question: The Corps' evaluation of the stability of the Seaway Locks was carefully confined to overturning and sliding only. They did not evaluate the locks for other problems including "severe concrete deterioration at the concrete-rock interface, major structural cracks, or the existence of weak seams or other foundation deficiencies which could effect the stability of the locks." In the judgment of your engineers, do these problems exist? How serious are these threats to lock stability?

   Answer: We are concerned with structural cracks developed in the culverts at both locks. The post-tensioned anchors proposed by Gannett Fleming would not only improve the stability against overturning but correct the crack problem. Based on the concrete-to-rock corings performed at both locks in the summer of 1986, Gannett Fleming concluded there is good bond between concrete-rock interface at all ten test cores. We are not aware of any serious foundation deficiencies at either Eisenhower or Snell Lock. According to the original Corps of Engineers' foundation reports, the Corps conducted numerous exploration corings to investigate the foundation conditions at both sites and concluded that the foundation was acceptable without any grout treatment. We have no reason to believe that the foundation at either lock has deteriorated. We plan to take additional rock corings at Snell Lock this winter in order to further investigate the current foundation condition.

2. Question: What specific work items are included in the $18 million request now before the Office of Management and Budget? Which are related to overturning and sliding, which to other stability problems, which to other problems?

   Answer: The $18 million request would provide remedial measures required to increase the factor-of-safety against overturning and sliding for all lock walls at Eisenhower and Snell Locks. In addition, the proposed post-tensioned anchoring will remedy all internal structural cracks. The deteriorated concrete near the bottom of Eisenhower Lock would also be completely repaired.

3. Question: Assuming that the Corps' judgment is correct relating to overturning and sliding, what would be the consequences to the continued safe operation of the locks from these other problems?

   Answer: The major concern in addition to the external stability of the structure is the existing structural cracks along culverts at both locks. Although $5.4 million was expended during 1968-69 to install post-tensioned anchors for the purpose of closing the cracks, we observed the cracks have not been completely closed and therefore, the anchors are subjected to possible corrosion by the water leaking through the cracks. Should the anchor(s) become corroded and lose

Subject: Answers to Oberstar's Questions
December 3, 1987 Hearing

December 22, 1987

their strength, it is possible that the monolith could move substantially or fail as a result of high earth and/or groundwater pressure or earthquake acceleration. Our proposed remedial work for correcting the external stability deficiencies would, at the same time, alleviate the concern on any of the structural cracks.

The other problem was identified as the deteriorated concrete near the bottom of Eisenhower Lock. Under our current plan, the concrete repair work will be incorporated in the construction of floor struts which is part of the stability work designed by Gannett Fleming. Although not having direct impact to the sliding stability of the lock walls, the continued deterioration of the concrete at the toe of the structure could undermine the overturning stability. This work should be scheduled within the next three to five years regardless of whether or not the strut construction is carried out.

4. Question: Can the Corporation address these other work items under its regular operating budget or would it have to seek additional funds?

Answer: The Corporation will be unable to fund the post-tension anchoring work under its regular operating budget because of the extraordinary expense (estimated above $10 million). However, the Corporation should be capable of handling the concrete repair at the bottom of Eisenhower Lock estimated at $1.5 million without a special appropriation.

5. Question: Mr. Knight raised the possibility of the existence of undetected cracks in the Seaway lock walls. Is their a readily-available means to detect such cracks? Would the stability work proposed by the Seaway Development Corporation have corrected any potential risks posed by such cracks?

Answer: No, there isn't a readily-available means to detect such cracks except the extensive removal of the backfill material or borings. However, the remedial measures proposed by Gannett Fleming will correct any potential risks posed by such cracks.

6. Question: Did the Seaway Development Corporation request the Corps to perform the reevaluation which led to their conclusion that no remedial measures for stabilizing the lock walls are needed at this time?

Answer: No, the Corporation did not request the Corps to perform the reevaluation although the Buffalo District personnel has been kept informed with the progress of the project. The Corps initially announced their current position in August 1987 after your subcommittee's hearing on July 15, 1987.

GANNETT FLEMING

TESTIMONY TO THE PUBLIC WORKS AND TRANSPORTATION SUBCOMMITTEE
ON INVESTIGATIONS AND OVERSIGHT

December 3, 1987
F. James Knight, President
Gannett Fleming Geotechnical Engineers, Inc.

Background

Our firm was contracted by the Saint Lawrence Seaway Development Corporation in May 1986 to perform an analysis of lock wall stability for the Eisenhower and Snell Locks. That study was to be an extension of the preliminary evaluation performed by the Buffalo District, Corps of Engineers, and completed in 1985. We were directed to perform specific explorations, in situ and laboratory tests, and detailed theoretical evaluations of wall stability. We were provided with extensive background materials including the Corps' 1985 report, construction plans and specifications, and copies of current Corps of Engineers' manuals dealing with the subject of study. Our charge was to generally follow Corps of Engineers' criteria; to determine if stability problems existed; to evaluate alternative corrective measures as appropriate; and to design rehabilitation works for the lowest-cost acceptable alternative.

Our firm has extensive experience with Corps of Engineers' projects. I have personally worked on assignments directly under contract for at least ten different Corps of Engineers' Districts. We are familiar with Corps' procedures, practices, and criteria. While we have always found the Corps to be conservative in their approach, we generally agree with that prospective and share with them that philosophy. If you had asked me a year ago, what if any disagreements I might have expected from the Corps on this assignment, I believe I would have told you that we might be questioned about not being conservative enough. Specifically, we have included in our analyses the force related to shear resistance between the lock walls and the soil backfill. It has not been the Corps' past practice to do that. We did so because that force is real, it does improve theoretical stability and by including it we could reduce the cost of repairs.

In reality we have encountered difficulty in reaching a unified position with the Corps because they feel we have been too conservative. While being complimentary of the overall quality and professional nature of our work, they have stated that we did not go far enough in the relaxation of standards. Not only do they believe we should have included the structure-to-backfill shear, but that we should have employed a less conservative method of analysis and that the acceptable safety factors for these structures should be lowered below normal limits.

Gannett Fleming's Analysis

We analyzed the SLSDC lock walls by both the Limit Equilibrium (LE) and the Shear Friction (SF) methods. [The difference between the two methods of analysis are shown on the attached exhibit. Simply stated, the LE method assumes that wall movement must occur to reduce the soil pressures behind the wall, while the SF method assumes that no wall movement will occur and utilizes measured soil pressures.] The resultant safety factors do not meet

the Corps' standard criteria for either approach. While we found the lowest stability values using the SF method, we believe that approach is the most appropriate for these structures. We believe that is correct because we measured very high earth pressures behind the walls. Those pressures are higher than were anticipated in the original design and higher than were estimated in the Recon Study performed by the Buffalo District. Further, those high pressures are still present despite the fact that the walls have already experienced some movement and partial failure. All four walls (two at Eisenhower and two at Snell) were found in 1967 to have cracked. Those cracks were repaired by the Corps in 1968-69 at a cost of $5.4 million. Anchors were installed across the cracks, within the walls. It is important to note that the repairs did nothing to improve stability but only induced a force across the observed failures to prevent additional crack propagation. When we analyzed the lock walls, using the earth pressures measured in our study and a finite element method, we found that the loads are still sufficient to cause the observed cracks, and also that cracks may have occurred at another location within the walls where they are not observable and therefore may not have been detected. Engineering problems inherent in the situation include: (1) the presence of the high earth pressures (measured by two confirming methods); (2) the fact that wall movements which have already occurred have not removed those pressures; (3) the indeterminate amount of movement required to lower the pressure; and (4) the indeterminate amount of movement necessary to cause a disabling failure of the locks.

Difference of Opinion with Corps' Prospective

We have two basic differences of opinion with the Corps' current position:

1. The Corps has stated that the SF method of analysis which we employed is too conservative. They hold that the high earth pressures we measured will be reduced by small and acceptable movements. Therefore, they believe the LE approach, which does not include application of earth pressures, is more appropriate.

We contend that both the amount of movement necessary to achieve earth pressure reduction and the allowable movement of the walls before a systemic shutdown to the Seaway occurs, are unknown and indeterminate. We therefore believe the method of analysis utilized (and which has been the Corps historically employed approach to similar problems) is correct for this case.

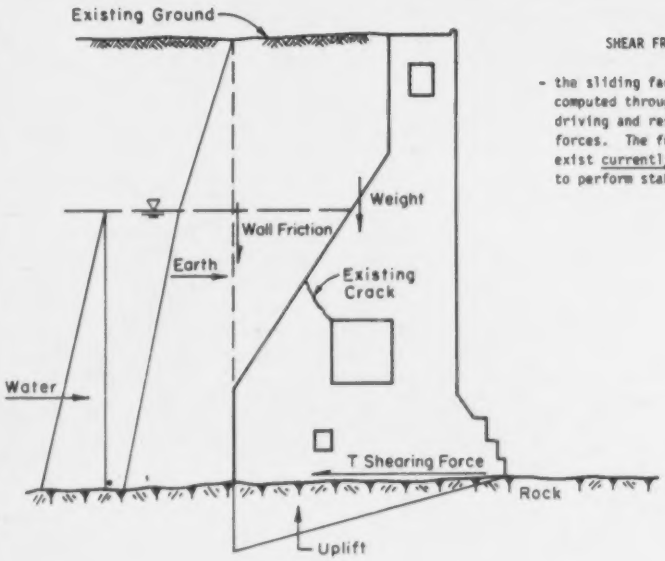
2. The Corps has proposed that factors-of-safety below the normally accepted range are adequate for these structures. Their draft ETL (Engineer Technical Letter) covering "Stability Criteria For Existing Concrete Navigation Structures On Rock Foundations" states that standards may be lowered "when the remaining life of the structure is relatively short or when there are no indications of any stability problem".

While we concur with the philosophy of lowered factors-of-safety for existing structures in some circumstances, we are troubled by the application of that approach in this instance. The Seaway's locks are

clearly expected to have a long remaining life. Further, we believe that the previously described cracks are indicative of stability problems. Our analysis shows that the earth pressures which caused those partial failures are still there. We conclude that the continuation of that condition may lead to more serious consequences. We therefore cannot endorse the relaxation of accepted and long-standing criteria for this instance.

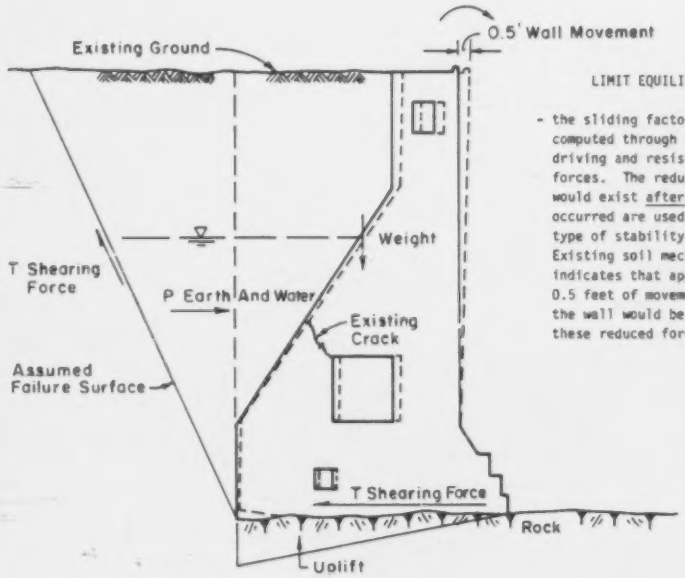
Conclusion

As stated in our letter to the Seaway dated September 14, 1987: "In our professional opinion the Eisenhower and Snell Locks do not possess adequate reserve strengths to assure that failure will not occur. While we cannot say that failure is imminent, or that it will in fact occur, neither can we give assurance that failure will not occur. The margin is too close for us to not, therefore, recommend corrective actions to restore the factors-of-safety to current, accepted levels".



SHEAR FRICTION METHOD

- the sliding factor-of-safety is computed through summations of driving and resisting horizontal forces. The full forces as they exist currently on the wall are used to perform stability analyses.



LIMIT EQUILIBRIUM METHOD

- the sliding factor-of-safety is computed through summations of driving and resisting shearing forces. The reduced forces as they would exist after wall movement has occurred are used to perform this type of stability analysis. Existing soil mechanics theory indicates that approximately 0.5 feet of movement at the top of the wall would be required to induce these reduced forces.

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December 31, 1987

Congressman James L. Oberstar, Chairman
Subcommittee on Investigations and Oversight
B 376 Rayburn Building
Washington, DC 2-515

Dear Congressman Oberstar:

As requested by your letter dated December 16, 1987, I have answered several additional questions concerning the Eisenhower and Snell Lock Walls. The additional questions posed by the Subcommittee and my responses are enclosed.

If you require further clarification or desire any additional information, please do not hesitate to contact me.

Very truly yours,

GANNETT FLEMING
GEOTECHNICAL ENGINEERS, INC.

F. JAMES KNIGHT
President

FJK:JD:tn

Enc.

From Subcommittee's 12/16/87 Letter to F. James Knight

QUESTIONS FOR MR. KNIGHT

In your oral presentation you raise the possibility of the existence of undetected cracks within the lock walls, possibly in locations where they are not observable. What are the potential implications of such cracks?

Is there a readily-available means to detect them?

Would the GFGE proposal have corrected for any danger posed by undetected cracks?

The Corps' evaluation of the stability of the Seaway locks was carefully confined to overturning and sliding only. They did not evaluate the locks for other problems including, as the testimony states, "severe concrete deterioration at the concrete-rock interface, major structural cracks, or the existence of weak seams or other foundation deficiencies which could affect the stability of the locks." In your judgment do these problems exist? How serious are these threats to lock stability?

GANNETT FLEMING

RESPONSES BY F. JAMES KNIGHT
TO ADDITIONAL QUESTIONS DATED
12/16/87 FROM SUBCOMMITTEE ON
INVESTIGATIONS AND OVERSIGHT

CRACKS IN LOCK WALLS

Finite element stress analyses of the four lock walls (two at Eisenhower Lock and two at Snell Lock) were performed by Gannett Fleming Geotechnical Engineers, Inc. (GFGE), as a portion of our assignment with the Saint Lawrence Seaway Development Corporation (SLSDC). These mathematical analyses indicated that internal stresses in the lock walls were higher than the strength of concrete at the two locations shown in Figure 1; these high internal stresses are due to the loads imposed on the walls by backfill soils and groundwater in the backfill soils. Because the analyses indicated that the internal stresses have exceeded the strength of the concrete, it was predicted that cracks have formed in the concrete at these two locations.

One of the crack locations, Crack No. 1, which was predicted by the finite element stress analyses has been verified visually in the field at both Eisenhower and Snell Locks. This crack location was known to the SLSDC and the Corps of Engineers (Corps) in the past, and repairs to this crack location were undertaken by the Corps for the SLSDC in 1968 at which time the crack was sealed and post-tensioning anchors were installed across the crack to prevent it from opening further. Observations of Crack No. 1 locations made from the filling culvert during the winter shutdown in January 1987 indicate that these cracks have either re-opened or were never completely sealed by the 1968 work; seepage was noted along the cracks and a heavy flow of water was noted at the crack in the south wall of Snell Lock (see reproduced photo in Figure 2). As was discussed in my testimony at the December 3, 1987 subcommittee hearing, this seepage may be causing corrosion of the post-tensioned anchors which were installed in 1968; however, because of the embedment of the anchors in the concrete this corrosion cannot be verified.

The other crack location, Crack No. 2, which was predicted by the finite element stress analyses has not been visually verified in the field. This crack location is not accessible from any existing culvert nor from the lock chamber and therefore cannot be readily viewed; borings would be required through this location to verify the actual presence of the crack. Such borings were not a portion of GFGE's scope of services during the lock wall investigations.

The potential implications of the cracks in the lock walls include:

- The original lock wall design calculations and stability analyses prepared by the Corps in the 1950s indicate that it was never intended for the walls to crack; the walls were assumed to act as monolithic units (i.e., the entire wall cross section acting as a unit) not as broken segments. Additionally, stability analyses that have been performed by the Corps and GFGE in recent years have also assumed that the walls will act as monolithic units. All of these analyses would have to be re-evaluated if the cracks were not repaired and the broken segments remained.

• If allowed to act as broken segments, the potential movement of the walls is less predictable than if the walls were to act as monolithic units as intended by the original Corps design. Wall movement is less predictable because the exact location of crack propagation is difficult to determined, and it is uncertain when or if cracks could widen and lengthen, or even break entirely through the walls. Such crack propagation could potentially occur during an earthquake event resulting in wall movement that restricts miter gate or tainter valve operations. These possibilities have not been fully investigated during past studies.

• As mentioned in my testimony, seepage and actual water flow have been observed exiting these cracks into the filling culvert. This water may be causing corrosion of existing post-tensioned anchors. If existing post-tensioned anchors should break due to corrosion at some future date, propagation of Crack No. 1 is possible with the same consequences as described above.

• Deterioration of concrete was observed near the Crack No. 1 location in the south wall filling culvert of Snell Lock due to ice wedging, and freeze-thaw conditions. This deterioration will continue if the crack is not repaired.

• It is possible that changing water pressure in the filling culvert, during the lock filling operations, could cause water surges through the cracks which could wash away backfill soils, creating a void behind the wall. This possibility has not been fully investigated during past studies.

The consequences of segmental wall movement have not been investigated during GFGE's study because GFGE's proposed stability modifications to the lock walls would not only resolve external stability deficiencies (sliding and overturning) but would also serve to correct internal wall cracking problems. As is shown on Figure 1, proposed inclined anchors have been located such that they would pass through the location of Crack No. 1, and proposed girdling anchors have been located such that they would pass through the location of Crack No. 2. The installation of the proposed anchors would prevent the propagation of these cracks and would ensure that the walls acted as monolithic units as intended by the Corps' original lock wall design. Additionally, grouting procedures which are included in GFGE's proposed stability modifications would fill the cracks with grout and would attempt to correct seepage which is currently exiting through the cracks.

SEVERE CONCRETE DETERIORATION AT CONCRETE-ROCK INTERFACE

Ten borings were performed during GFGE's study to investigate the condition of the concrete-rock interface beneath lock walls. Six of these borings were drilled at Eisenhower Lock and four were drilled at Snell Lock. None of these borings indicated concrete deterioration nor is there any reason to suspect concrete deterioration at other interface locations.

MAJOR STRUCTURAL CRACKS

Major structural cracks are known to exist (Crack No. 1, Figure 1) or are predicted to exist (Crack No. 2, Figure 1) in the lock walls, the consequences of these cracks have been discussed in detail elsewhere in this submission.

WEAK SEAMS OR OTHER FOUNDATION DEFICIENCIES

Shaly seams are known to exist within the dolomite bedrock and are likely weaker than the surrounding dolomite. The strength properties of the weaker, shaly seams have been used in GFGE's stability calculations, and, proposed lock wall stability modifications have accounted for the presence of these shaly seams.

Two other conditions have come to GFGE's attention during our lock wall study which would potentially impact the lock walls. These conditions include: (1) the potential presence of voids up to 10 inches thick in the bedrock 25 to 40 feet below the Snell Lock Walls, and (2) the presence of a 10-foot thick gypsum seam approximately 44 feet below the Eisenhower Lock Walls.

Three borings obtained in July 1987 by the Corps at Snell Lock indicate the presence of voids in the dolomite bedrock, generally between 25 to 40 feet below the base of the lock walls. The presence of such voids is not uncommon in bedrock units such as the dolomite found at Snell Lock; dolomite is somewhat prone to solution activity (the formation of voids) caused by groundwater movement through fractures in the bedrock. However, the Corps' original foundation report for Snell Lock, dated 1958, indicates that testing conducted by the Corps at that time showed that voids were not a problem and grouting of bedrock voids was not considered to be necessary. Similarly, the Corps' original foundation report for Eisenhower Lock, dated 1958, indicates that voids were not a concern at Eisenhower Lock.

GFGE's boring program was not designed to investigate to depths where the potential voids have been suggested by the Corps' recent drilling program, therefore we have no first hand knowledge about the size or severity of these voids. While these potential voids have no affect on the sliding or overturning stability of the lock walls, the presence of voids beneath the lock walls could affect the walls at some future date if collapse of the voids were to occur resulting in wall settlement. To my knowledge these issues have not been addressed by anyone since the original Corps' foundation reports were published in 1958; GFGE's scope of services with the SLSDC did not include these issues.

The Corps' original foundation report for Eisenhower Lock, dated 1958, indicates the presence of a 10-foot thick gypsum seam located approximately 44 feet below the base of the Eisenhower Lock Walls. Because this type of bedrock is extremely prone to solution activity (the formation of voids) caused by groundwater movement through fractures in the bedrock, the Corps took extra precautions during construction by installing a grout curtain into the bedrock to protect the gypsum seam from void formation caused by flowing groundwater. Additionally, the Corps installed monitoring wells which were to be monitored during the construction period and on a regular basis during lock operations to determine if the quantity of groundwater flow through the gypsum seam is increasing; an increase in the quantity of groundwater flow would be indicative of solution activity in the gypsum seam and the formation of voids. While such voids would have no affect on the sliding or

overturning stability of the locks walls, the presence of voids beneath the lock walls could affect the walls if the voids were to collapse and cause wall settlement.

GFGE's scope of services with the SLSDC did not include investigation of the condition of the gypsum seam and we have no first hand knowledge of data that has been collected from the monitoring wells by the SLSDC. Such data would indicate if voids are developing in the gypsum seam.

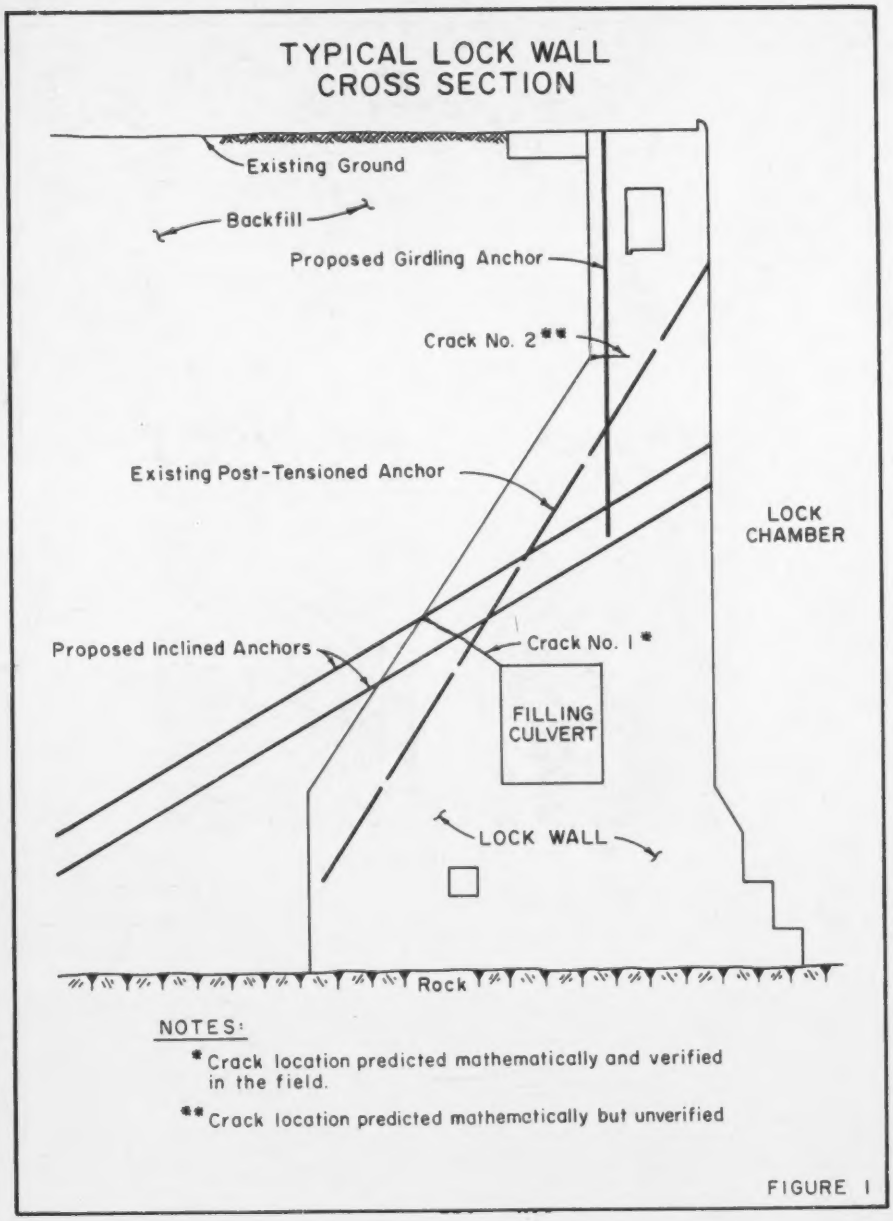
TYPICAL LOCK WALL
CROSS SECTION
Existing Ground
Backfill
Proposed Girdling Anchor
Crack No. 2**
Existing Post-Tensioned Anchor
LOCK
CHAMBER
Proposed Inclined Anchors
Crack No. 1*
FILLING
CULVERT
LOCK WALL
Rock
NOTES:
* Crack location predicted mathematically and verified in the field.
** Crack location predicted mathematically but unverified

FIGURE 1

CRACK LOCATION NO. 1
SOUTH WALL SNELL LOCK
JANUARY 1988

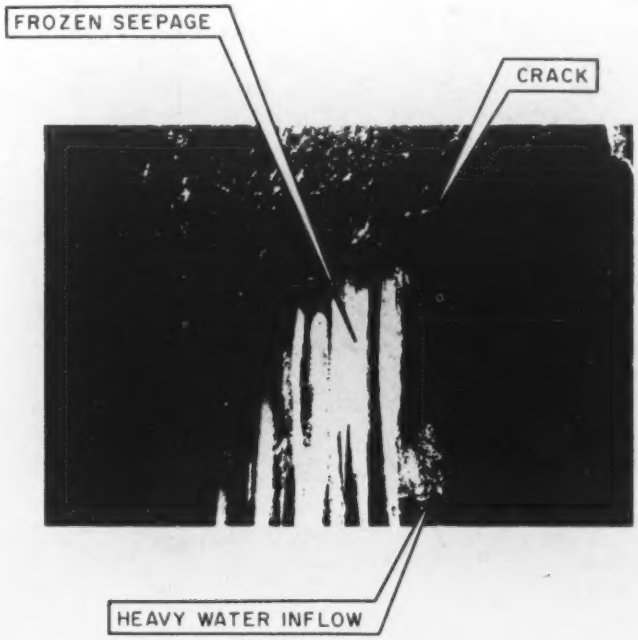

FIGURE 2

[The following additional item was received for the record:]

Harper, Eaton, Peterson & Orman

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December 3, 1987

Honorable James L. Oberstar, M.C.
2351 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Oberstar:

RE: St. Lawrence Seaway Development Corporation

Thank you very much for the attentive and respectful manner in which you presided at the hearing today on lock repair of the St. Lawrence Seaway System.

Mr. Duscha was certainly correct when he stated that it was unusual for the Corps of Engineers to relax the design, construction and safety standards of a waterway system. This is something I never expected to hear from the U.S. Corps of Engineers.

Indeed, the distinguishing characteristic between the work of the Corps and that of private constructors has been the unswerving devotion of the Corps to conservative design, durable construction, and thorough dependability of its waterway systems.

Private industry may consider a five-year return of investment and a ten-year throw-away life an acceptable measure of quality. Consider, however, that the average corporate chief executive will be retiring in about five years, he is much concerned with the profitability of his term of office, and cares little for the problems devolving on his successor.

As you and I have often discussed, however, government must not only preserve its past values, but also prepare a future for citizens yet unborn.

It was not this short-range attitude that built the Panama Canal, the Great Lakes-Seaway System, or the Mississippi-Missouri-Ohio Waterways so vital to our economy.

Harper, Eaton, Peterson & Orman

It may be that a businessman can talk in terms of a cost/benefit analysis. In our case, however, we should talk in terms of a cost/catastrophe analysis.

The shipowner must pay the wages and benefits of his crew, retire the principal and interest on the ship mortgage, build a reserve for maintenance and drydock expense, and otherwise meet expenses in excess of $4,000.00 per day. A breakdown in the waterway system represents an uninsured loss to the shipowner and the cargo shipper. The ship does not earn its keep and the cargo is dead inventory until the ship resumes its mission of transporting goods from the point they are produced to the point where they are needed.

Recognizing this, the longshoremen's union in Duluth/Superior has foregone its traditional right to strike (although they bear much of the obloquy for the grainmillers' work stoppages) and this is typical of a dedication throughout the system to keep the cargo moving.

In this equation, a controllable unknown factor is unacceptable. Any step we can reasonably take to assure dependability should be taken. Any step which adds to uncertainty and therefore detracts from dependability should be rejected.

In this critical period when our overseas customers are making their plans for the coming year, I ask that we come down with a clear vote in favor of dependability of the Seaway system. We will never know if our repairs were an excess of caution if the system continues to function smoothly. This is to the body politic as vaccination to the physical body: if we do not suffer untimely death from smallpox, we will never know if the vaccination was, in fact, needed.

But if the patient comes down with smallpox, the argument is over and the undertaker awaits.

Judged on a cost/catastrophe ratio, the repair work proposed by the Corporation is a bargain in which we should invest, and happily never know the value of the investment we have made.

Harper, Eaton, Peterson & Orman

My thanks for your patience in listening to us and in reading this letter. Your foresight in calling the hearing on this subject is much appreciated.

Yours very truly,

Conrad M. Fredin

CMF/dlr